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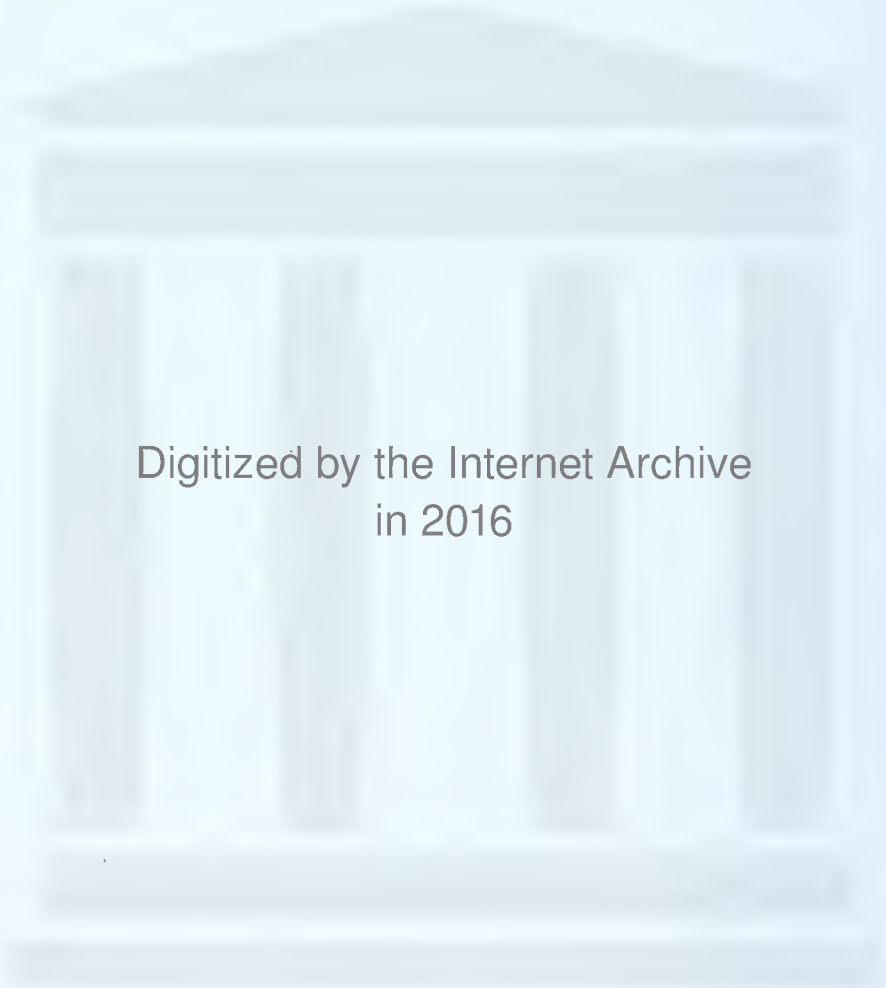

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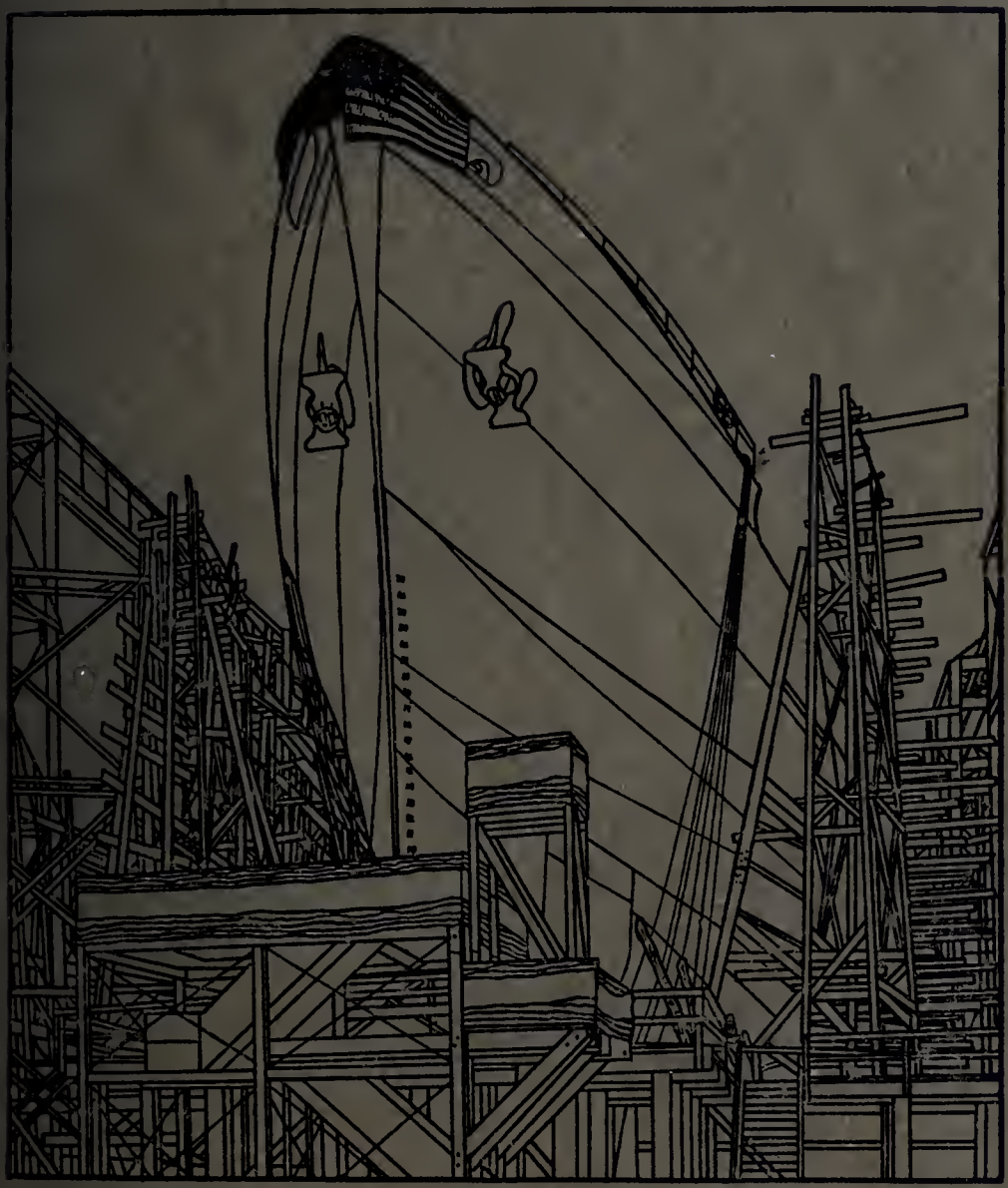
STAGE BUILDING AND SHIP CARPENTRY



BULLETIN 345-R

Commonwealth of Pennsylvania
DEPARTMENT OF PUBLIC INSTRUCTION
February, 1943

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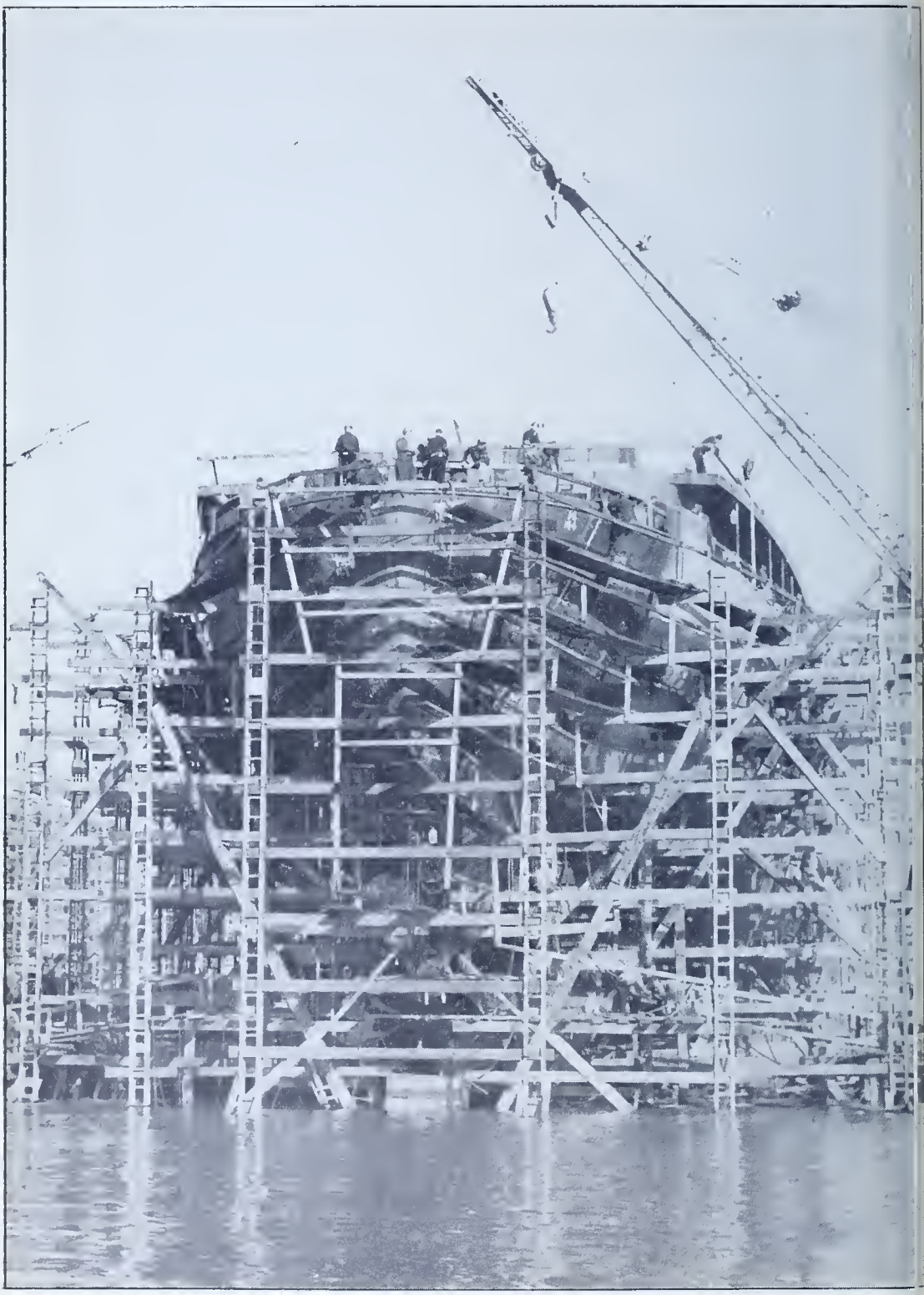

Staging at the Stern of a Tanker

STAGE BUILDING AND SHIP CARPENTRY

(A Manual of Instruction for Beginning and Advanced Stage Builders and Ship Carpenters)

Bulletin 345-R

Prepared by the

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF PUBLIC INSTRUCTION
DIVISION OF INDUSTRIAL EDUCATION

In Cooperation With

SUN SHIPBUILDING AND DRY DOCK COMPANY
CHESTER, PENNSYLVANIA

SCHOOL DISTRICT, CITY OF CHESTER
CHESTER, PENNSYLVANIA

and

UNITED STATES OFFICE OF EDUCATION
FEDERAL SECURITY AGENCY

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Commonwealth of Pennsylvania
DEPARTMENT OF PUBLIC INSTRUCTION
Harrisburg
1943

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In Cooperation With the
United States Office of Education
The Federal Security Agency
Washington, D. C.

Foreword

This manual of instruction is intended for training beginning and advanced stage builders and ship carpenters. The rapid expansion of shipbuilding, with the resultant increase in the number of persons to be trained, has prompted the development of this publication.

The units of this manual have been organized and developed with the aid of experienced foremen and mechanics — persons who are specialists in stage building and in ship carpentry. Standard specifications and detail drawings are employed as an aid to the beginner.

The procedures presented are specifically those which are followed in the yard of the Sun Shipbuilding and Dry Dock Company. While it is conceded that many of the methods and work procedures may not be applicable in all shipyards, it is believed that a great part of the contents will be found useful in training stage builders and ship carpenters to meet similar shipbuilding situations wherever these classes of mechanics are employed.

Acknowledgment is made to the Sun Shipbuilding and Dry Dock Company, Chester, Pennsylvania, for assistance and cooperation in making the preliminary analysis and in preparing instructional materials.

Special acknowledgment is extended to F. A. McShane, Carpenter Foreman; to J. C. Fry, Assistant Carpenter Foreman; to Frank Stevens, Stage Builder Leader; to A. Bedwell, Launching Crew Leader; and to J. S. Witt, Leader, Stage Building and Repair, for materially assisting in the preparation of text material, sketches, and photographs. These men served as technical advisers during the preparation of this manual.

Appreciation is extended to William A. Brock, Coordinator of Industrial Education, to Chester School District, and to D. Francis Hallowell, Coordinator of Chester Area Vocational Training for War Production Workers program, for assistance in this work.

This manual of instruction was prepared at the Chester Field Curriculum Laboratory of the Pennsylvania Department of Public Instruction. Charles Johnston, Adviser, Division of Industrial Education, and Robert Jacoby, Instructor, Hershey Vocational School, supervised the preparation of materials at the Laboratory.

This unit was completed under the direction of Charles F. Zinn, Adviser, Division of Industrial Education, and under the general supervision of Paul L. Cressman, State Director of Vocational Training for War Production Workers, and Urwin Rowntree, Chief, Division of Industrial Education.

FRANCIS B. HAAS
Superintendent of Public Instruction

February, 1943

INTRODUCTION

Scope of the Manual

The manual *Stage Building and Ship Carpentry* is intended for use in the training of beginners and in the training of advanced workers engaged in the various jobs included under the general heading of stage building and ship carpentry.

The material for the training of the beginning workman gives information and typical work experiences performed by beginning workers in their particular craft. It is presupposed that the learner has had little or no experience in this field of work.

Advanced training is intended to give training necessary for the further development of the helper, or the worker who has not yet reached a first-class rating.

This manual has been prepared for the instruction of stage builders and ship carpenters who work *on the ship* rather than for shop workers in these crafts.

Use of the Manual

In this manual the beginning parts, including the topics of related information, are items of general information which workers in both crafts should know. The remainder of the manual contains specific jobs performed by each of the crafts. These jobs are broken down into various operations. The worker who understands the general information, the related information, and the performance of the various job operations can combine his knowledge to perform new and more difficult jobs.

The job units or operations are cumulative in nature; that is, many of the operations learned in the beginning of the course will appear again as parts of other and more difficult jobs. Many operations may also apply indirectly to other work being done.

The Job Sheets

Each major job performed by the stage builder and ship carpenter is treated individually by giving the following information about the particular job in

question: general information, specific safety precautions, tools needed for doing the job, materials and equipment needed, other mechanics needed, procedure for doing the job, and questions.

The general information regarding each job points out certain technical information about the work to be done. It directs the attention of the trainee to the important items on the job.

It is very important that every trainee shall understand the meaning of trade terms as they arise on the various jobs. Definitions and abbreviations are given in the appendix. The trainee should master these terms as they arise.

The trainee should study carefully all sketches and photographs. They are included to clarify the written explanation of jobs.

Specific safety precautions are listed so that hazards may be pointed out and avoided. Questions are included as a review of the material presented.

Duties, in General, of the Stage Builder and Ship Carpenter

The jobs and procedures presented in this manual are strictly those which are followed in the Sun Shipbuilding and Dry Dock Company. The jobs performed by each craft may vary from yard to yard, and there may be several procedures for various jobs; the procedures listed in this manual, however, are generally accepted practices. The work performed by the shipwright in many yards is included in this manual as jobs of the stage builder and ship carpenter.

The stage builder is the first craftsman to begin work on the ship and the last to leave. His work consists mainly of providing stages or scaffolding from which other craftsmen work. Staging the side shell of the ship, the tanks, the engine room, and under the decks are only a few representative jobs.

The stage builder in the Sun Shipbuilding and Dry Dock Company works side by side with the ship erector in setting, plumbing, aligning, and supporting the work of the erectors. The ship carpenter often assists in the plumbing and aligning of work. In many yards this work is done by the shipwright.

In the production of the modern steel ship, where the use of wood is kept to a minimum, the ship carpenter must have a working knowledge of metal as well as of wood. Typical work experiences of the ship carpenter are: laying ceiling, installing machinery foundations, building gratings, laying decks, etc. Another important job of the ship carpenter is from the beginning of the

construction of the ship to make preparations for launching it; he builds launchways and packs the ship. After the launching he recovers the launching materials.

General Instructions to New Men

One of the important jobs of the beginning worker in both crafts is to secure tools and materials from many parts of the yards and ways. It is important, therefore, that new men become familiar with the locations of the various storerooms, tool rooms, stock piles, and other important places about the yard. Stage builders, for example, often need to take materials to the carpenter shop for surfacing and cutting. The beginning worker should walk cautiously about the yard until he is familiar with the common hazards of walking through the yards; once he thoroughly knows the dangers, he should continue to be cautious in the light of his newly acquired knowledge.

The storerooms and tool rooms for stage builders are located under the ways upon which the ship is being erected. Tool rooms where special tools and equipment are kept are located at numerous points in the yard.

The trainee should be on the alert at all times when crossing the yard or when walking along traffic lanes, and he should not change direction quickly without first looking about to see whether the way is clear.

The workman's badge must be shown at all tool rooms and storerooms, and a written order from the group leader must be presented before such tools and supplies can be issued.

The trainee should keep fully informed as to specific yard regulations by reading the notices which are posted on the bulletin boards throughout the yard.

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Part I
GENERAL SAFETY PRACTICES

The Introduction of the Safety Movement

The introduction of safety into industry has been a natural development. Production was speeded up when the use of machinery and machine tools superseded the handicraft of skilled mechanics. Workmen had to be trained to work safely with the new equipment at the same time new skills were being taught. Industrial accidents were frequent when machines were first introduced. The application of safety measures not only reduced the number of accidents, but actually increased efficiency.

Industry has tried for years to reduce lost-time accidents. It has accomplished much over a period of years; much remains to be accomplished. Safety education, therefore, is a factor of prime importance in any industry. By removing the cause of accidents, largely carelessness, a still greater reduction in the number of lost-time accidents is possible.

Safety education is a vital part of an effective accident prevention program. If new workers are to be wide-awake to the many hazards around the shops and yards, their attention must be directed to these dangers. Lectures to workers, posters showing the effects of carelessness, reading material, and safety contests are only a few of the methods used to make workers safety-conscious.

A safety department is located within each shipyard. The duty of the safety engineer is to note common hazards, to be on the alert for new dangers, and to study accident reports so that the recurrence of accidents may be prevented. It is the duty of every worker to cooperate with the safety engineer by practicing safety measures and by reporting particular hazards, that the worker has observed, to the proper safety officials.

Before beginning work, new employees usually receive safety instruction under the direction of the safety engineer. The safety engineer stresses the general safety rules of the yard at this preliminary meeting.

Today when industry is pressed for greater production and when the influx of new workers is great, the matter of safety becomes more and more im-

portant. The most practical means of keeping accidents at a minimum is to develop a safety consciousness in employees and to train them in safe work practices. A trainee cannot be considered properly trained until he can do two things: first, perform skillfully and accurately the work required of him; and second, do that work in a manner which is safe for himself and others. Workers must be thoroughly impressed with the idea that only a safe worker is a good worker.

Accidents mean a loss both to the worker and to the employer. The dangerous worker is not only a hazard to himself, but also to the workmen about him. The best safeguard against accidents is a safe workman; therefore, safety practices should be taught to the worker, insisted upon by the yard, and observed at all times by the employees.

Safe and Orderly Working Surroundings

The two principal causes of accidents are: first, unsafe procedures on the part of the workman; and second, unsafe working environment. Keeping working surroundings physically and mechanically free from danger is important. Typical hazardous practices are as follows:

1. Working on staging which does not have a back rail.
2. Working in dark rooms with insufficient light.
3. Working where tools are scattered carelessly on the floor.
4. Working where excess scrap materials litter the floor.
5. Working in the midst of make-shift electrical wiring.

Working under disorderly conditions often makes a workman careless. Each worker should take the responsibility of keeping his working space free from hazards. Where unsafe conditions cannot be remedied, the workman must be extremely cautious.

Proper Lighting

Adequate light should be provided at all times; however, special care should be taken to prevent glare. Aisles, stairways, and dark rooms need to be well-lighted.

Improper lighting has been responsible for many accidents. It is extremely difficult to work in poor light. Working under poor lighting conditions causes fatigue, which increases accidents.

This caution is particularly applicable to the ship joiner, who often is required to work where artificial light is necessary.

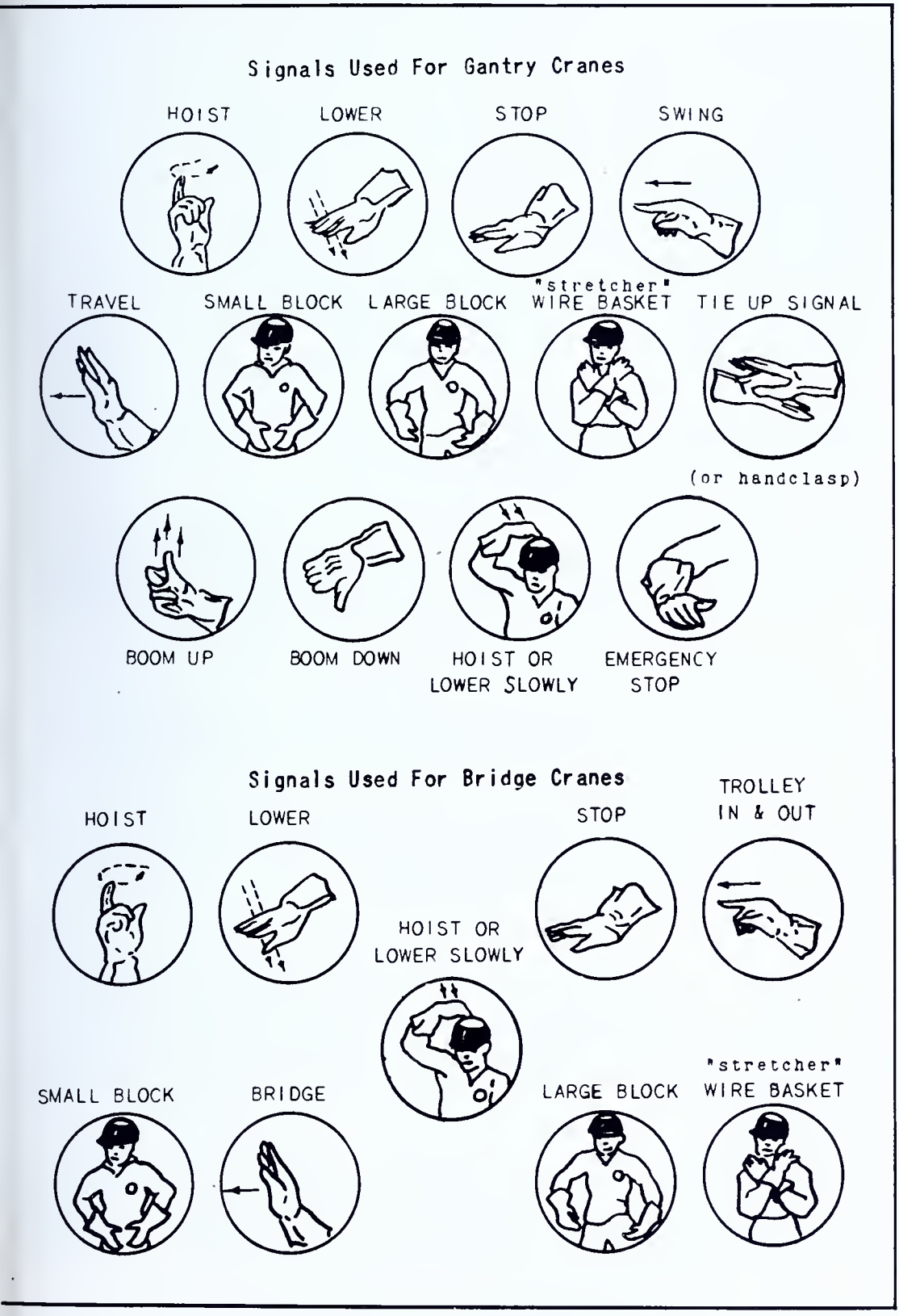


FIG. 1 — *Conventional Signals Used in the Shipyard*

A temporary-light man is available at all times to install temporary lighting where needed.

Hazards Which the Stage Builder and Allied Workers Must Consider

1. Hazardous climbing.
2. Leaking gas hoses.
3. Improper shoring.
4. Danger from overhead or falling objects.
5. Danger from explosive gas (during repair work in or near tanks and pipe lines).
6. Taking risks.
7. Daydreaming.
8. Tampering with electric switches or fuse boxes.

Crane Signals

The only person who should signal to a crane operator is the man who has been authorized to do so. See Fig. 1.

Loose Clothing Hazard

Stage builders and allied workers climb and work at considerable heights. Shirts, especially the sleeves, should not be loose enough to catch on staging and throw the workman off his balance. Long or turned-up cuffs of overalls are particularly dangerous; cuffs should be removed entirely or sewed into position to prevent the possibility of dragging.

Staging Hazards

In climbing or assembling staging where men are working underneath, the stage builder should take special precautions not to drop tools or materials on the workers below. The most common hazards are dropping tools and tripping over loose objects.

When bulkheads or other heavy members are handled, parts of the staging may be damaged. When this occurs, take down all loose parts before such pieces fall without warning. Notify the safety man or the staging foreman at once so that the damaged section may be repaired as quickly as possible.

If guardrails are to be removed to facilitate placing material on the ship, the safety man must be informed and the parts must be replaced by the

workers who removed them. In any event, guardrail should not be removed unless absolutely necessary; and when it is removed, special precautions should be taken by all workers. See Fig. 2.

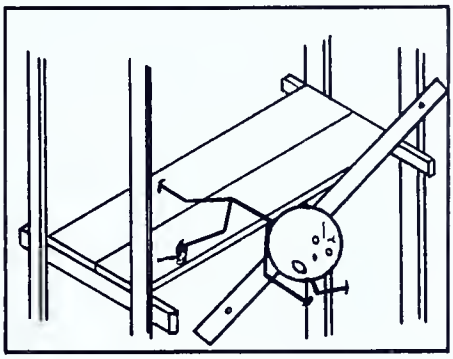


FIG. 2 — *Loose Guardrail*

GAS AND AIR HOSE SAFETY

All shipyards use the various gas hoses listed below, but the colors and sizes of the hoses may vary from yard to yard. The description given below is characteristic.

The *gas hose* used for rivet heaters' pots is made of smooth, black rubber 1¼″ in diameter.

The *air hose* for heaters' pots is a corrugated, black hose also 1¼″ in diameter.

The *oxygen hose* has about the same appearance as the heaters' hose, but it is only about ⅝″ in diameter.

The *propane or acetylene gas hose* is a red hose, also ⅝″ in diameter; it is used in connection with the oxygen hose.

Propane is a highly explosive gas. In a pure state, it merely burns freely; but when mixed with the correct amount of air it becomes highly explosive. It is especially dangerous because it is heavier than air and flows toward the ground instead of rising like other gases. A small welding flame is sufficient to ignite this low-lying gas.

Stage builders and shipwrights do not work directly with these various hose lines, but the hose lines are constantly a part of their working surroundings. Avoid cutting or breaking hose lines by dropping sharp-edged objects on them.

The first concern of the stage builder in the event of a broken hose is to warn other workmen to get away from the escaping gas. See Fig. 3.

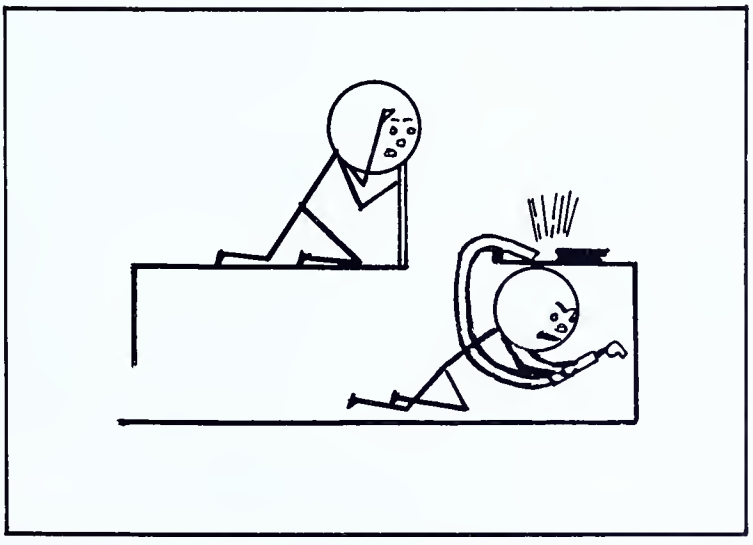


FIG. 3 — *Look for the Man Who is Using the Hose*

All valves should be turned off as quickly as possible, and the hose repairman should be notified at once.

Safety in Shoring

Shoring the various ship members is an important operation of the stage builder or shipwright. If not done properly, it can be a hazard to stage builders, shipwrights, and other workers on the job.

Before shoring to the clip which the welder has attached, see that it has been thoroughly welded. See Fig. 4. This examination is simply a routine check on the welder who might tack a clip and fail to weld it completely.

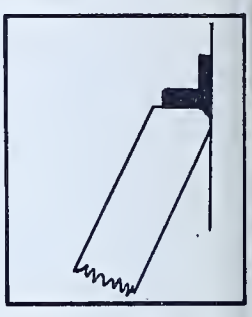


Fig. 4 — *Neatly Fitted Shore*

In order to provide adequate strength, the welder should tack the clips on the under side as shown in the figure of the shore fitted to the clip. This is particularly true where a nearly vertical force is exerted on the clip.

Shores should be well-grounded and wedged tightly into position. It is important that the shore should be cut to fit the angle of the wedge neatly. See Fig. 5. Shoring of the bottom shell is done while the crane is still attached. This shoring should *never* be begun before the bottom shell has been fastened to the keel plate.

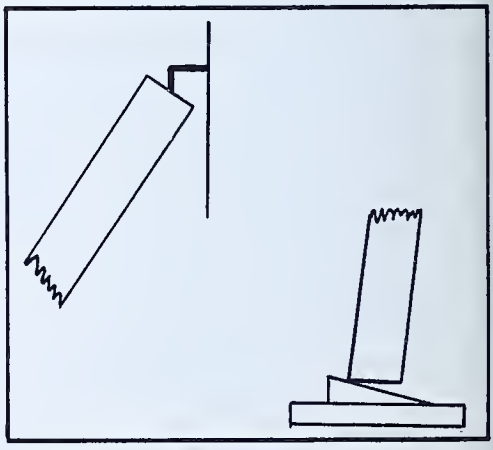


Fig. 5 — *Improper Shoring*

The crane is never released from an erection until the group leader has determined that the member has been properly braced and shored. Cables and temporary shores cannot be removed until such erections have been securely fastened and braced by supporting members.

Safety Hat and Safety Shoes

Stage builders and allied workers *must* wear safety hats at all times. See Fig. 6. Safety shoes are recommended, but not required. In all cases wear a strongly built, ankle-fitting work shoe. Safety belts are available when the work being done requires this added support. All these items may be secured from the safety store of the company.

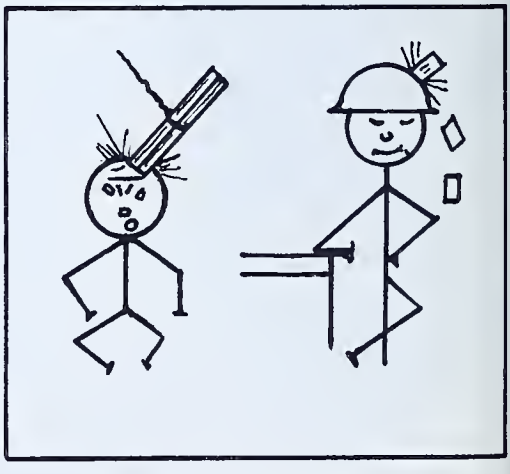


Fig. 6 — *Safety Helmet*

Piling Materials Properly

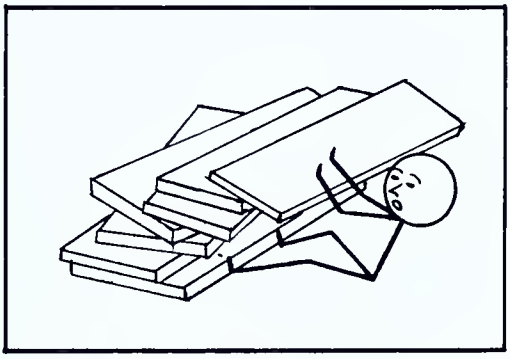


Fig. 7 — *Falling Boards*

Pile materials securely and in such a position as not likely to be jolted or knocked over. See Fig. 7. Keep piles of materials within safe heights, and pile in such a manner as to make them accessible without disturbing the entire pile. This calls for suitable storage space for all materials. Furthermore, each person using such materials must make himself responsible for keeping such materials in the proper place.

Specific Safety Precautions

1. Lift heavy objects carefully.
2. Grease on the ways is slippery and may cause a serious fall.
3. A man should never work without a companion in an enclosed tank or room.
4. Inspect all clips to see that they have been fully welded.
5. Report to the dispensary, no matter how slight the injury.
6. Report hazardous conditions to your leader.
7. Replace any staging which has been moved.
8. Cover all open holes.
9. Do not wear loose-fitting clothing.

QUESTIONS

1. **If a gas hose should break, what would you do?**
2. **To whom should hose leaks be reported?**
3. **What has been the result of the safety education movement?**
4. **What does "safety conscious" mean?**
5. **What are the duties of the safety engineer?**
6. **A trainee is not properly trained until he can do what two things?**
7. **Why is lighting a hazard to workmen?**
8. **Name some common staging hazards.**

Part II

GENERAL DESCRIPTION AND USES OF COMMON TOOLS

Tools Used by the Stage Builder

1. Hatchet
2. 7-point saw
3. Brace and bit, 11/16″ and 13/16″
4. Open-end wrench, ¾″
5. 6′ Rule
6. 50-foot tape
7. Carrying hooks
8. Nail bar
9. Level
10. Square
11. Declivity board
12. Wire reel
13. Block and tackle

Tools Used by the Ship Carpenter

1. Bits, ¼″ to 1″
2. Plug bits, 1″ to 1⅜″
3. Chisels, ⅛″ to 2½″
4. Fore plane, 18″
5. Jack plane, 14″
6. Smooth plane, 7″
7. Block plane, 6″
8. Spokeshave
9. Hack saw
10. Carborundum stone, 8″ x 2″ x ¾″
11. Level
12. Straightedge
13. Dead-rise board
14. Center punch
15. Scriber
16. Expansive bit
17. Framing square
18. Try square
19. Ball peen hammer, 12 oz.
20. Ship adz, 4½″ blade
21. Broadax
22. Brace, 10″ sweep
23. Screwdriver and bits (¼″ to ½″)
24. Countersink bits
25. Nail sets, 4 sizes, 1/32″; 1/16″; 3/32″; and ⅛″
26. Combination squares, 12″ blade
27. 6′ rule
28. Dividers, 10″
29. Claw hammer, 12 oz.
30. Ship bevel
31. 8-point handsaw
32. 7-point handsaw
33. 5-point handsaw (rip)
34. Drawknife, 12″ blade
35. Wood rasp, medium
36. 50′ tape
37. Slick chisel, 2½″ blade, 20″ long
38. Chalk line
39. Plumb bob
40. Calking tools: mallet, sticking iron, spike iron, crooked iron, dum iron, single-groove and double-groove making iron
41. Level
42. Calipers
43. Hatchet
44. Wood vise, 6″ x 3″ jaws
45. 4″ C-clamp
46. 6″ C-clamp
47. Bench stops
48. Augers, 9/16″ to 2″

49. Crosscut saw, 2-man
50. Hand drills
51. Plug bits, 1⅛″ to 1½″
52. Cold chisel
53. Ship augers, ½″ to 2½″
54. Adjustable wrench
55. Pin maul

Open-end Wrench

The open-end wrench may also be called a non-adjustable or solid wrench. Open-end wrenches are made in many varieties and sizes. The head of the wrench is usually set at an angle of 15 degrees with the center line of the handle. Because the wrench needs considerable clearance, it cannot be used in small corners or inconvenient places. Since each wrench is made for a particular nut size, it is a practical wrench on jobs where one or two standard bolt or nut sizes are used.

A spud wrench is single-ended, and has a long, round-pointed handle. See Fig. 8. The purpose of the round-pointed handle is to align different steel members or staging brackets so that a bolt may be inserted through the aligned holes.

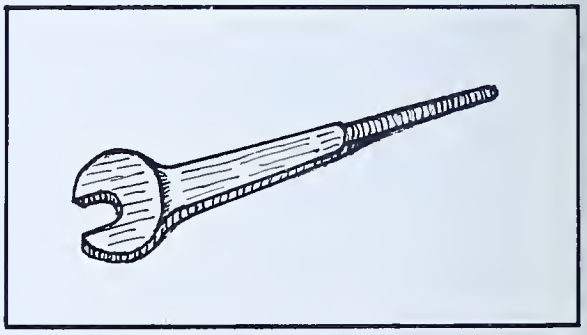


Fig. 8 — *Spud Wrench*

Each wrench has the nut size stamped at some convenient place on the wrench for quick identification. Care must be taken to use a wrench of the correct size. When too large a wrench is used, the sharp corners of the nut are soon rounded. This ruins a nut in a very short time. The correct size of wrench opening for any particular bolt size can easily be determined by multiplying the bolt size by 1½ and adding to the product ⅛ of an inch. Open-end wrenches are designed to withstand about the same force as the bolt for which the wrench is designed. Excessive force on the wrench will break either the bolt or the wrench. Never hit a wrench with a hammer; a jolt with the palm of the hand is usually sufficient to tighten the nut. Occasionally a short piece of pipe is slipped over the handle of the wrench to provide additional leverage.

Hatchet

The hatchet head is made from a special steel and then heat treated. The eye in the head and the end of the hickory handle that fits the eye are treated to exclude moisture. The handle is wedged tightly into the head with metal wedges. The advantage of the hatchet is that it may be used either for hammer-

ing or for rough cutting. See Fig. 9.

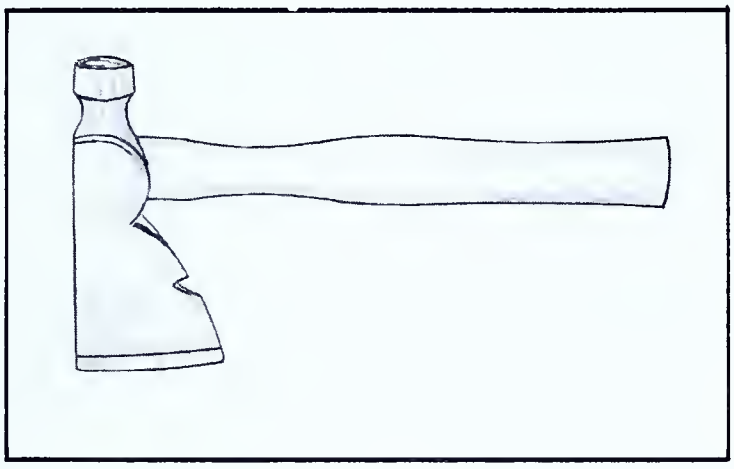


Fig. 9 — *Hatchet*

The cutting edge of the hatchet is ground on both sides, and it is tempered to hold a sharp cutting edge.

The hatchet is used particularly for cutting timber down to rough size. For ordinary use it should be grasped near the end of the handle; however, for lighter cutting the hand may be slid nearer to the middle of the handle.

Hatchet handles do come loose, and sometimes the heads fly off. When a hatchet head becomes loose, drive a metal wedge into the handle. If this does not tighten the handle properly, replace the handle.

Level

The level is used by the stage builder as well as by the ship carpenter.

The level is a tool used for plumbing or leveling, that is, for bringing work to an exact vertical or horizontal position. The instrument is sometimes made of metal, but more often of wood. The level is a long, rectangular piece of wood. Glass tubes almost filled with a non-freezing substance are inserted in the two ends and in one or both edges. A small bubble rides in the glass tube and must be aligned with hair lines on the glass tube in the leveling operation. See Fig. 10.

For accuracy, use the longest level possible; they are made in lengths of 6 to 48 inches.

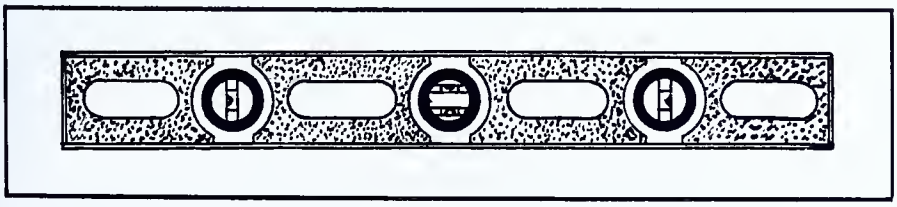


Fig. 10 — *Level*

Crosscut Saw

Crosscut saws are used for cutting across the grain. One type of crosscut saw, shown in Fig. 11, is used by one man for ordinary sawing. Figure 11 shows the names of the parts of the handsaw.

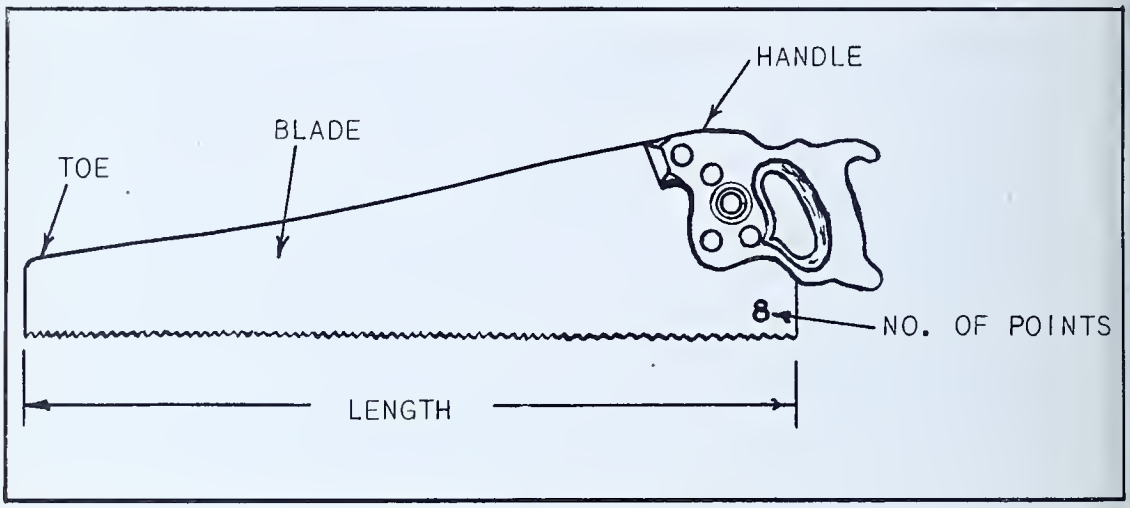


Fig. 11 — *Parts of a Saw*

Another type of crosscut saw shown in Fig. 12 is used by two men for sawing heavy timber.

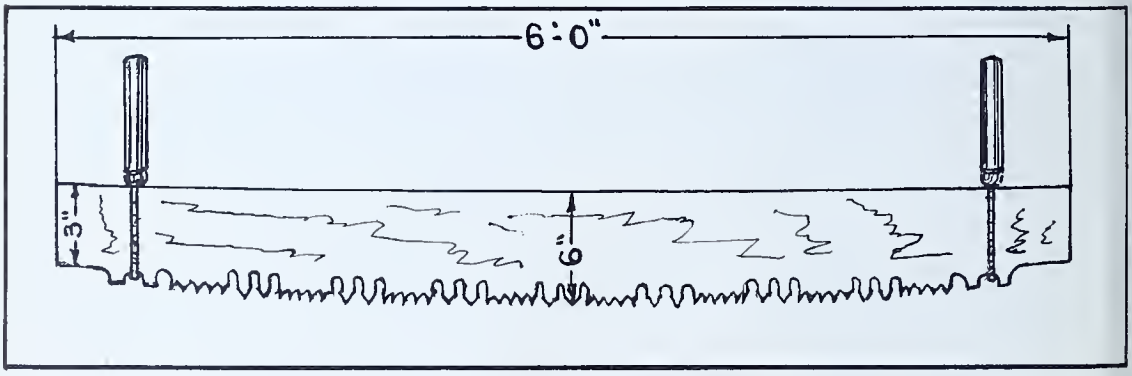


Fig. 12 — *Two-Man Crosscut Saw*

The ordinary handsaw is a highly tempered steel blade to which a wooden handle is bolted. The blade of the saw is from 2 to 3 inches wide at the toe end and increases in width as it approaches the handle. This widening increases the strength of the blade and prevents the saw's buckling.

The steel from which saws are made is highly tempered, hard, and tough; yet it is easily set and filed.

Saws must be set to give the blade clearance as it cuts through the board. "Set" in a saw is provided by bending alternate teeth in an opposite direction. As the saw cuts through the wood, the cut which it makes is wider than the thickness of the saw blade. This enables the saw to cut through the wood freely without binding or sticking. Figure 13 shows the set of a crosscut saw. Saws used to cut heavy planking should have particularly wide set.

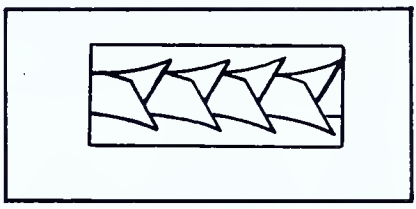


FIG. 13 — *Set in Saw Teeth*

The teeth of a crosscut saw can easily be identified. The teeth are relatively pointed and are filed to a bevel on one side. See Fig. 14. Since the teeth are set, these beveled teeth form a series of knife-like points which cut off the wood fibers as the saw is drawn across the wood.

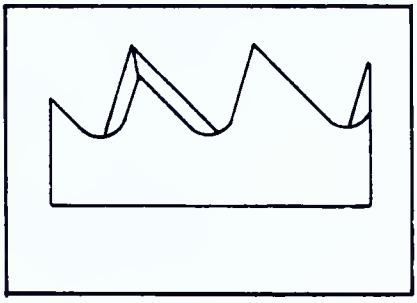


FIG. 14 — *Shape of Crosscut Saw Teeth*

In order to have the saw cut properly, the mechanic must have the work at a convenient height and hold the saw so that its cutting edge is at an angle of approximately 45 degrees with the work. See Fig. 15. Rest the work high enough to keep the saw blade from striking or digging into the ground. When starting to cut, rest the heel of the blade on the line to be cut, rest the thumb of the left hand on the blade of the saw, and draw the saw upward. This will make a small groove to guide the saw on the downward stroke. The strokes from this point on should be long and even.

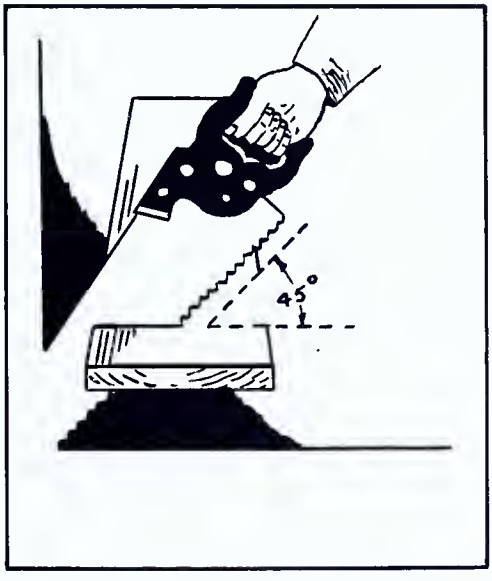


FIG. 15 — *Cutting Angle for Sawing*

The two-man crosscut saw, Fig. 12, is a highly tempered steel blade. The shape and approximate sizes are shown in the figure. A wooden handle is bolted on at each end of the blade. When the saw is in use, two men, one at each end, pull the saw back and forth by means of the handles.

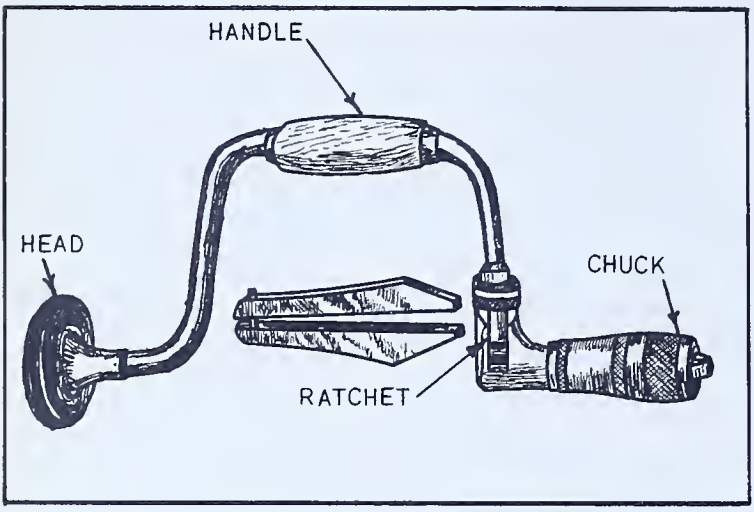


FIG. 16 — *Brace*

BRACE AND BIT

The stage builder has frequent use for the brace and bit, which are used for boring holes in lumber. The most important parts of the brace are shown in Fig. 16. The chuck of the brace is equipped with jaws which securely hold a square-shanked bit.

Figure 17 shows and names the parts of the bit. There are many kinds of bits in use; the most common type, however, is known as the auger bit. Bits are usually made in sizes from ¼″ to 1″; they increase in size by 16ths of an inch. The size of the bit is identified by a number stamped on the shank of the bit. The identification numbers indicate 16ths of an inch; therefore a number 8 bit will bore a ½ inch hole.

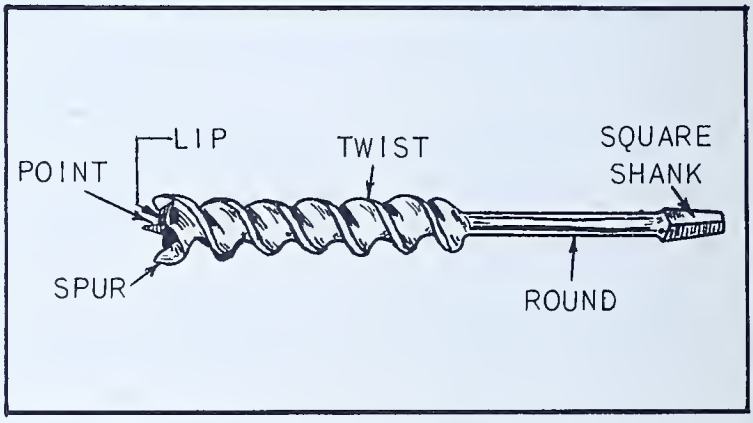


FIG. 17 — *Bit*

The screw at the end of the bit serves an important function. It centers the bit, keeps it from drifting away from the hole, and draws it into the wood. Auger bit points or screws may be of three varieties: coarse, medium, or fine screw. The coarse screw is most adaptable for boring heavy, wet, green lumber.

When a hole is to be bored, the exact center of the hole must be marked accurately. Fasten the bit into the brace securely, and place the screw point of the bit exactly on the center marking of the hole. The head of the brace is held with the left hand, and pressure is applied on the head with the body as the brace is revolved in a clockwise direction.

If connections are to fit together properly, holes must be bored perpendicularly. The beginner may want to stand a square alongside the bit as a check. After some experience, however, the mechanic will simply sight along the bit for squareness. After a bit has entered the wood for a considerable distance, do not attempt to change the direction of it. Invariably such a stress will bend or break it.

Using a Plumb Line

The term "to plumb" means to make a line or a surface perpendicular to (or at right angles to) a horizontal plane. The plumb bob is a pear-shaped metal object pointed at the bottom and equipped at the top with a hole into which the plumb line is attached. See Fig. 18.

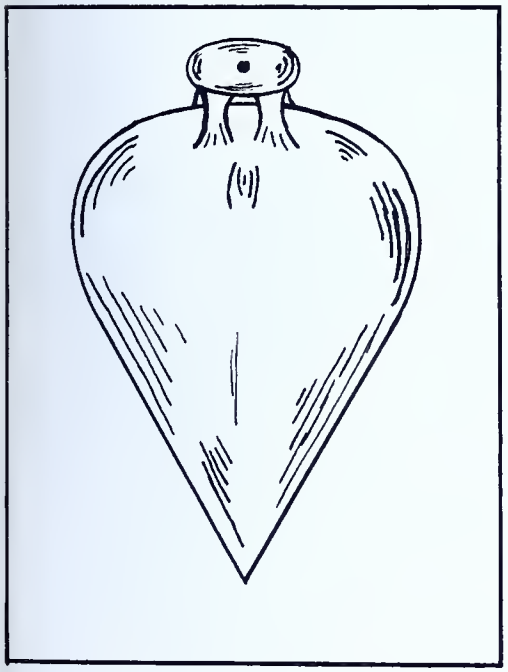


Fig. 18 — *Plumb Bob*

In long, vertical distances where a point several feet below must be lined up with a given point above, a level cannot be used. In this case a plumb bob is used. Since plumbing is an important operation, the use of the plumb bob will be discussed in the chapter on *Related Information.*

Straightedge

The straightedge is a guiding or testing tool which is made of clear, straight-grained wood. The double straightedge has the two edges straight and parallel. This straightedge is used primarily for leveling purposes.

A good straightedge is a highly prized tool, and it must not be thrown about carelessly. When a straightedge is not in use, it should be hung at a prescribed place in the tool room. If it is permitted to lie around, other workmen will walk on it, pile materials on it, or otherwise bend, twist, or batter its edges.

Fifty-foot Tape

Stage builders, shipwrights, and carpenters use the 50-foot tape frequently for measuring lengths of staging members, for establishing draft marks, for determining declivity, etc. Long tapes are made from strong cloth material

or from steel ribbon. The steel tape is more durable and accurate than any other type. When the tape is not in use, it is wound into a leather-covered reel; a loop at the extreme end keeps the tape from being lost in the case. The long tape is usually graduated to one-eighth of an inch.

Shipwright measurements, in particular, must be made correctly and accurately. It is important, therefore, for stage builders and shipwrights to know how to use the tape properly.

Before a steel tape is used for a particularly accurate measuring job, it should be checked with an official tape which is used only for checking purposes. Many mechanics check their tapes periodically once or twice a week. To make the check, unreel the two tapes side by side, place the zeros even, and check the last foot marking with the official tape. If there is any discrepancy at this point, do not use this tape for accurate work.

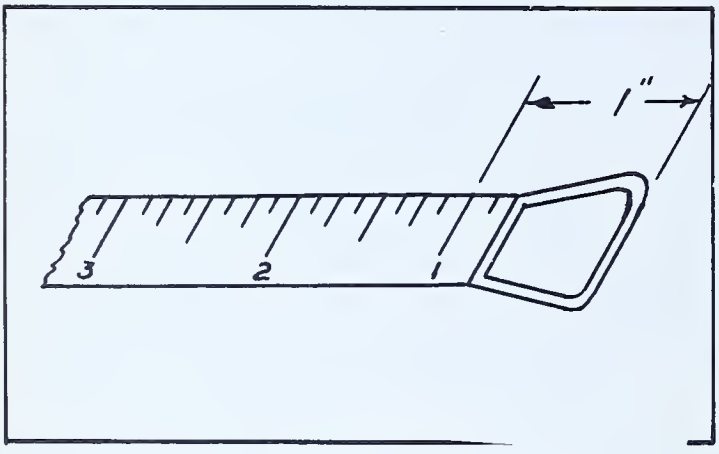


FIG. 19 — *Loop on 50-foot Tape*

The loop at the end of the tape serves three purposes. See Fig. 19. It prevents the tape's being lost in the case; it affords a convenient means of drawing the tape from the case; and it provides a means of holding the end of the tape in the actual measuring operation. This measurement is always taken from the outside end of the loop.

The steel tape is a fragile, sensitive measuring tool. When taking measurements, keep it straight and avoid sharp kinks. A kinked tape is inaccurate and weak at such points. Avoid walking on the tape whenever possible. If a tape is to remain in a stretched position for any length of time, lay a board beside it. The edge of the board will prevent anyone's actually stepping on the tape.

When long measurements are to be made, the tape must be held straight, tight, and without kinks or twists. Pressing a line directly to a mark usually produces a sharp kink in the tape. If the line is drawn past the actual work and pressed down to the mark with the left hand, as shown in Fig. 20, the tape may be used without kinking or twisting.

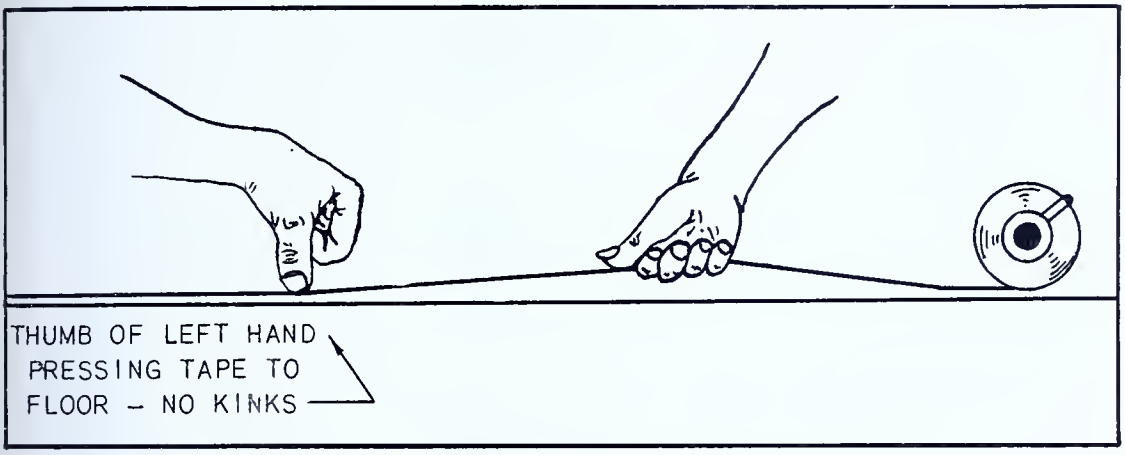


FIG. 20 — *Proper Method of Using a Long Tape*

FOLDING RULE

The six-foot folding rule is very useful for measuring short distances. Folding rules are made of wood or metal and have the advantage of folding the 12 sections into a fairly compact bundle, usually about $\frac{3}{4}''$ x 2″ x $7\frac{1}{4}''$ in size.

The folding rule is useful for general work because it can be easily carried about, it can be adjusted at the joints to form an angle, it can be adjusted to various convenient lengths, and it can be used to measure overhead distances.

The folding rule is not so accurate as the steel tape. Constant wear from opening and closing the rule tends to loosen the joints and take measurements inaccurately. A few drops of oil should be placed on the metal joints frequently to reduce wear.

USE OF CHALK LINE

A chalk line is used to mark a straight line which is too long to be marked with a straightedge. The chalk line is a light, strong cord. It is rubbed over a piece of colored chalk, stretched tight between the two given points between which a straight line is to be drawn, and then picked up at or near the center and let go sharply. It is important that the string should be picked up straight rather than at an angle. Snapping the line from an angle usually lays a crooked line. The shipwright uses a chalk line for placing lines on keels and keel blocks. See Fig. 21.

It is important that the chalking of the line should be done properly. If the line is drawn over the same place on the chalk continually, the cord will soon cut through.

FIG. 21 — *Using Try Squares to Ensure Snapping the Chalk Line Vertically*

The chalk is shaped to fit into the palm of the hand with a flat surface exposed. To chalk a line properly, stretch the line tight and move the chalk back and forth along the under side of the line. At the same time revolve the chalk in the palm of the hand to prevent the cord's cutting into the chalk.

SCREWDRIVER

A screwdriver is a tool used frequently by the ship carpenter. It is used to tighten screws or bolts which have slotted heads.

Constant wear on a screwdriver bit makes the point rounded and tapered. A worn bit causes the screwdriver to slip from the slot and ruin the screwhead, and then it is difficult to get a good grip on the screwhead even with a perfectly shaped bit.

The end of the bit should be ground square; the sides should be straight and nearly parallel. See Fig. 22.

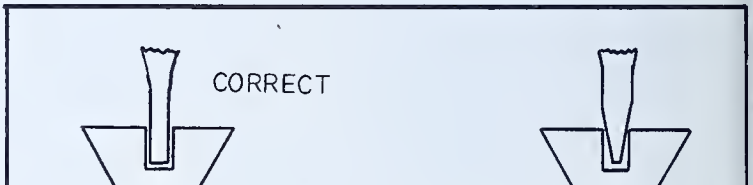


FIG. 22 — *Screwdriver Must Fit Slot Correctly*

When a number of screws are to be driven, the automatic screwdriver is used to save time. Instead of using the hand to grasp and release the screwdriver 20 to 25 times in driving one screw, one or two forward strokes on the automatic screwdriver will drive the screw home.

The automatic screwdriver can be locked and used as a hand screwdriver, and by throwing a shifter forward or backward, it may be used to drive or withdraw screws.

It is possible to use a large screwdriver on a small screw, provided the bit fits the screw slot; however, a small screwdriver should not be used on a large screw. The result in this case is usually a broken bit.

Cutting Pliers

There are many varieties of pliers, but those used in ship carpentry are known as cutting pliers. The hardened-steel cutting edges are used to cut soft wire (steel or copper), small nails, screws, etc. See Fig. 23.

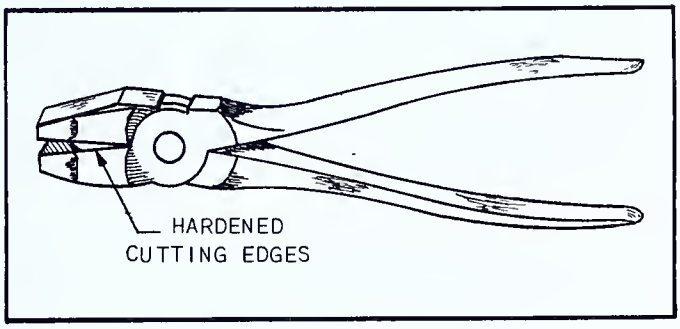


Fig. 23 — *Side Cutting Pliers*

The jaws of the pliers are grooved to prevent their slipping while holding work.

It is not good practice to tighten or loosen nuts with pliers. A wrench should be used for this purpose. It is permissible, however, to hold a bolt with pliers while the nut is being tightened with a wrench.

Never use the cutters to cut hard wire. When the cutters are nicked, they are useless.

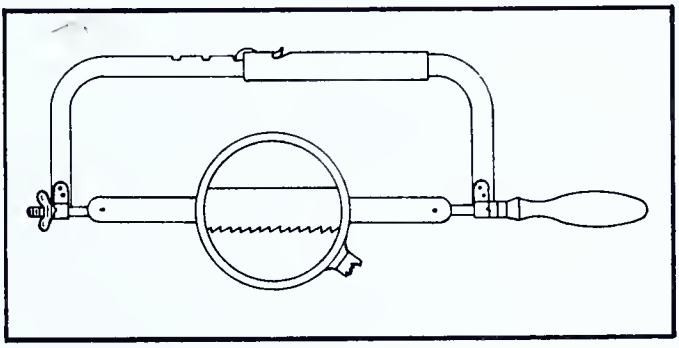


Fig. 24 — *Hack Saw*

Hack Saw

The saw used for cutting metal is known as a hack saw. The frame is made in two types: the straight handle, Fig. 24, and the pistol handle. Many frames are adjustable to accommodate blades of various lengths. The selection of the proper blade for the work being done is the important item. The number of teeth per inch on the blade is the most important item to consider in relation to the kind of metal being cut. For general work and for cutting the heavier metals, a 10-inch blade having 14 to 18 teeth per inch is very satisfactory. For thin angle iron, tubing, and sheet metals, a blade having 24 to 32 teeth per inch should be used.

The teeth of the blade should point away from the handle of the saw, and the blade should always be drawn tight. When sawing, use smooth, even strokes and relieve the pressure on the backstroke.

How to Hack Saw Properly

1. Select the proper blade.
2. Saw teeth should point away from handle of saw.
3. Keep the proper tension on the blade.
4. Hold the saw properly.
5. Do not saw fast; draw light, even strokes.
6. Do not drag the saw on the return stroke.
7. Use coarse-toothed saws on soft stock.
8. No lubricant is necessary when sawing by hand.

C-clamp

C-clamps are used to hold together parts being worked. The frame of the clamp, which is a drop-forged piece of metal in the shape of the letter "C", is threaded with one screw member, the end of which has a swivel head. When the head of the clamp is drawn tight, the head does not rotate. This arrangement prevents marring the work.

Ball Peen Hammer

The ball peen hammer, Fig. 25, is made from tool steel which has been hardened and tempered on both ends, the eye being left soft. The handle is made from straight-grained hickory and is shaped to fit the hand. The handle should be fitted well into the head, and it should be well secured with metal wedges. Never use a hammer with a loose handle or a loose wedge.

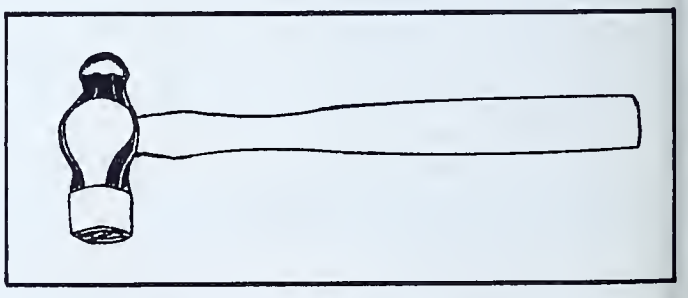


Fig. 25 — *Ball Peen Hammer*

Never strike a hardened surface with a hammer. The impact of hardened surfaces may cause small chips to splinter and fly from the hammer. These flying steel fragments often cause serious eye injury.

The ball peen hammer has a definite place on the job; avoid using bolts, bars of steel, or other makeshift objects in place of the hammer.

The handle of a hammer is evenly balanced in the head. The length of the handle may vary with the individual; however, the handle should be grasped near the end unless a very light blow is to be struck, in which case the hand may be moved slightly forward on the handle.

The Plane

The plane is a common carpentry tool. It is used to reduce wood stock to size and to produce smooth, straight surfaces. The most common planes in use are the smooth plane, the jack plane, and the jointer plane. All are constructed similarly, but are made in various lengths.

The beginning worker should be able to assemble a plane properly and adjust the blade properly. The most important feature of plane assembly is to place the plane iron properly. The cutting section is made in two parts: the cutter and the cutter cap, or chip breaker. The cutter is ground to a bevel on one side and made flat on the other. To this *flat side* the cap iron is fastened with a cap screw. The cap iron stiffens the blade and causes the shavings to curl from the mouth of the plane. The blade is placed into the mouth with the cutting blade down; a level cap holds the blade securely.

A plane will not cut unless adjusted properly. The depth of the blade may be too deep, or a transverse adjustment may have to be made so that the blade cuts the same depth on both sides. The depth of the blade is regulated by turning the adjusting nut forward or backward; transverse adjustment is made by moving a lateral adjustment lever to the right or left until the plane iron projects the same amount on both sides. See Fig. 26 for complete details.

When about to plane a surface, anchor the work securely; and before beginning to plane, inspect the plane and make the proper adjustments. Take light cuts. Press on the knob at the beginning of the stroke, and transfer the pressure to the handle of the plane at the end of the stroke. Whenever possible, take long, continuous strokes from one end to the other.

If a plane does not cut properly, one of several things may be the cause. The blade may be dull and in need of sharpening; the blade may be set too deep; the blade may not be adjusted level with the bottom of the plane; or the chip breaker may be set too close to the cutting edge of the blade.

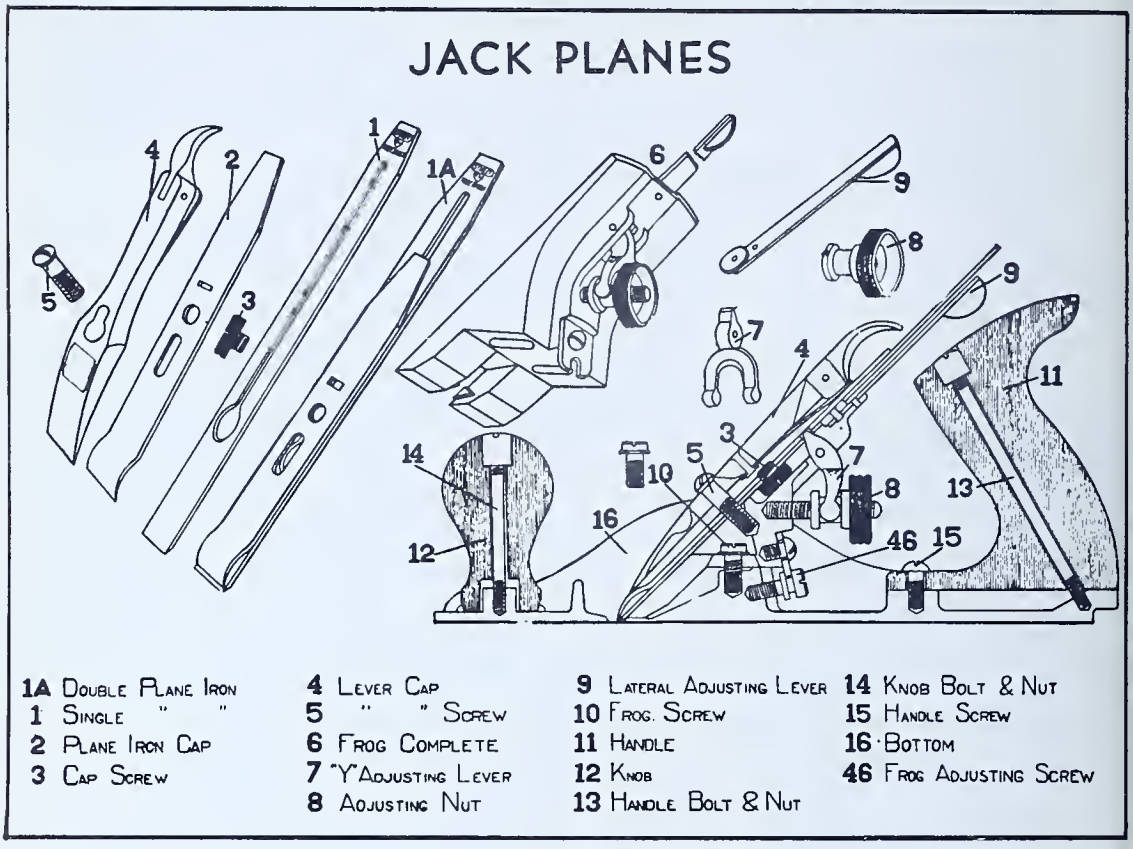


Fig. 26 — *Iron Plane Details*
Courtesy Stanley Rule and Level Co.

Tool Maintenance

A good craftsman is known by the tools which he has and by the condition in which he keeps them. Skilled workers sometimes do good work with dull tools, but the beginning worker cannot do a good job with dull tools. More than anything else, good tools will give the beginner the best possible start toward acquiring skill in his work.

Beginning workers should be encouraged to start tool boxes. Keep in mind that a few good tools are far better than a great many poor ones. Select the best tool available; make certain that the tool fits the worker, that it has the proper feel, and that it balances properly. This is important.

Whenever tools are not being used they should be in the tool box. The box should be arranged so that each tool has a certain place. If every tool has a place in the box, no tool will be thrown haphazardly against others, nicking sharp edges or otherwise impairing their usefulness. Such systematic care and placing of tools will insure their being readily at hand and in good condition when they are required.

Tools should be coated with oil to prevent rusting. This direction is especially applicable to the ship carpenter and stage builder who work in all kinds of weather and in wet basins where dampness usually prevails. If tools do become rusted, remove the rust at once with fine emery cloth and a good grade of oil. Above all, keep all edged tools sharp. A dull tool not only makes work difficult; it makes work dangerous. Learn to sharpen your own tools, and keep them sharp.

Sharpening an Auger Bit

Auger bits become dull from frequent use. Two parts of a bit get dull: the nibs and the lips or cutting edge of the bit. Bits can very easily be sharpened with a small file specially designed for the purpose.

The lips or the cutting edges of the bit are filed by placing the bit, point down, on the bench, and filing the upper side. An equal amount must be filed from each lip, otherwise one edge will be forced to do all the cutting. See Fig. 27.

The nibs are filed by holding the twist of the bit against the edge of a bench and filing the inside edge of each nib. Never file the outside of the nibs.

Crooked auger bits may be straightened by rolling the bit on a bench top to find the high spot. Strike the bit on the high side until the bit rolls true.

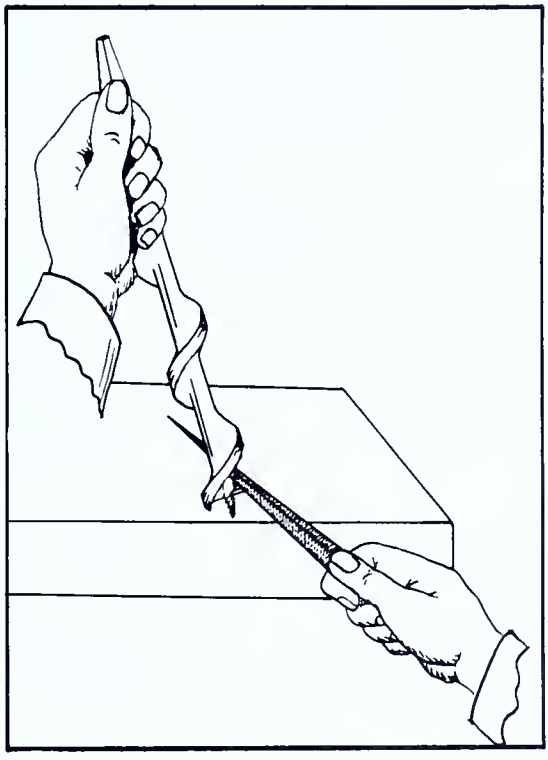


Fig. 27 — *Sharpening the Cutting Nibs*

Sharpening a Plane, Iron, Chisel, Etc.

A sharp-edged tool need only be ground when the edge has been nicked or has become rounded or worn down by much whetting or careless whetting. When grinding, move the plane iron from side to side to grind all parts of the iron. The iron should be ground straight and square. Keep the iron cool to prevent burning or softening the metal.

After the iron has been ground, whet the iron on a stone. Hold the iron as shown in Fig. 28, and move the plane iron back and forth. Keep enough oil on

FIG. 28 — *Whetting a Plane Iron*

FIG. 29 — *Removing Wire Edge from Plane Iron*

the stone to keep the stone moist. This whetting operation produces a wire edge on the blade. Remove the wire edge by sliding the iron across the stone with the face held flat. See Fig. 29. If the cutting edge is not sharp, repeat the same operations of whetting.

The hatchet and adz are sharpened similarly.

Part III

GENERAL INFORMATION CONCERNING A SHIP

Beginning workmen in any of the ship crafts should have a general understanding and knowledge of the ship as a whole; that is, the general layout of the vessel, the location of the various sections of the ship, and the terms used in identifying these parts. This information is necessary if the beginning student is to interpret intelligently the procedures which follow. Figures 30 and 31 show the general layout of the ship.

The ship may be divided longitudinally into three main sections: the fore end, the midship section, and the after end.

The following compartments (see Fig. 30) are located in the fore end of the ship.

(a) The forepeak is a dry buoyancy space except when used as ballast tank to level the ship.

(b) The dry cargo room is a space used for carrying supplies which are not in a liquid form.

(c) The fuel oil tank is located below the dry cargo compartment. It is used to carry the fuel oil supply for the ship.

(d) The chain locker room is a small room separated by a light bulkhead into two small sections. These two small compartments hold the anchor chains.

The tanks which hold the liquid cargo are located in the midship section. The main tanks are large tanks in the center of the ship. Smaller wing tanks are located on both sides of the main tanks. Bulkheads, which are vertical steel partitions, serve to divide the ship into the various airtight tank units.

Figures 30 and 31 show the tank divisions by dotted lines and number them from 1 to 9, beginning at the forward cofferdam and proceeding aft to the after cofferdam.

Each of these cross sections is divided into three parts: one wing tank port side, one center tank, and one wing tank starboard side. This makes a total of twenty-seven tanks, each separated from those adjoining by oiltight bulkheads. These bulkheads, at the same time, give the ship shape, contour, and strength. Three types of bulkheads are common: center tank transverse bulk-

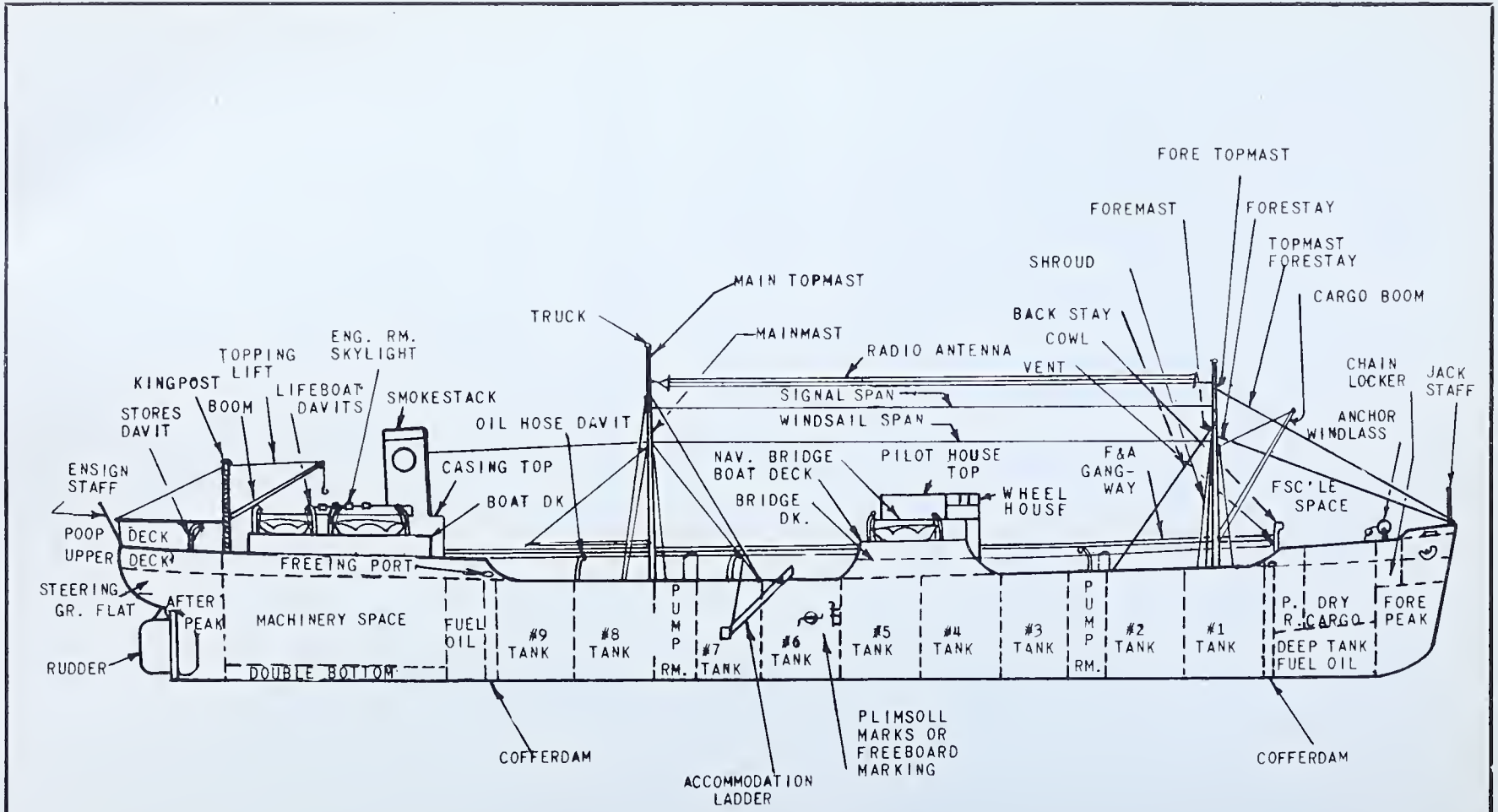


FIG. 30 — *Profile of a Tanker*

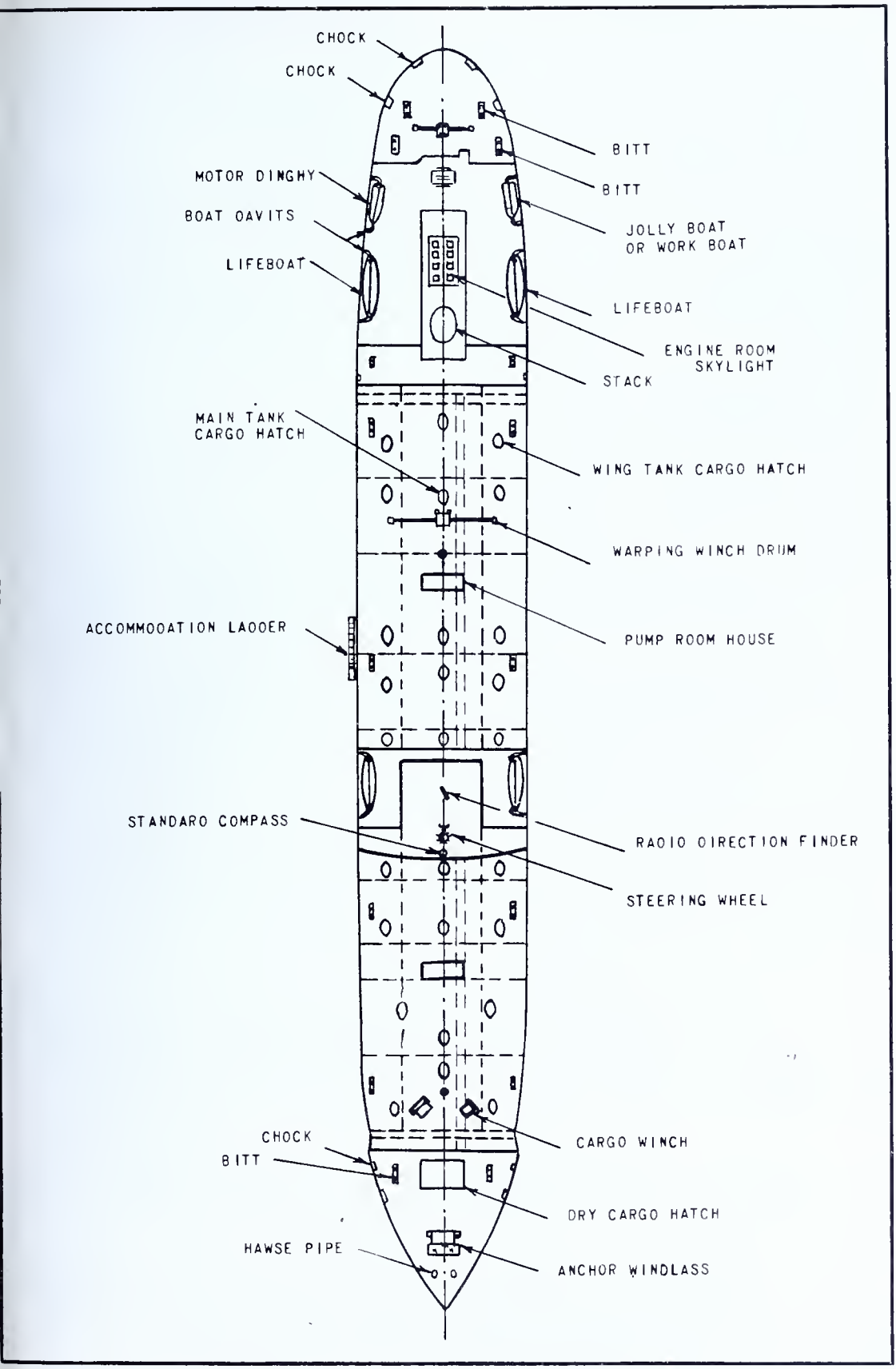


FIG. 31 — *Deck Plan View of a Tanker*

heads, transverse wing tank bulkheads, and longitudinal bulkheads. Transverse bulkheads extend across the ship at right angles to the center line; all longitudinal bulkheads extend in a fore-and-aft direction.

The forward and after cofferdams are double, watertight bulkheads placed between the oil tank and the dry compartments. These cofferdams serve to make safety compartments between the different parts of the ship.

The after peak is used as a dry buoyancy space or as a ballast tank. It corresponds to the forepeak compartment.

Immediately above the after peak is the steering gear flat, where the steering machinery for the ship is located.

The machinery space houses the main engines of the ship as well as the generators, pumps, condensers, and all other major equipment necessary to operate the ship. Notice, in Fig. 30, that the machinery space has a double bottom called the inner bottom or tank top. This inner bottom forms a large, level space for the strong construction which is used as a base for machinery. This double-bottom space is used for the storage of fresh water and, in some cases, the storage of fuel oil. In addition, this double bottom serves as a safety wall in case of damage to the bottom of the ship.

The upper deck on a tanker is the main deck, and it extends from one end of the ship to the other as shown in Fig. 30.

The forecastle deck is directly above the main deck at the forward end of the ship. The bridge deck is directly above the main deck amidship. See Fig. 30. The boat deck is above the bridge deck and is so called because the lifeboat stations are placed there. Above the boat deck is the navigation bridge or wheelhouse.

The shell plating of a ship is its outside surface, or covering, from the flat keel outward and up the side of the ship to the level of the deck and from end to end of the ship. This shell plating forms the ship's watertight covering which makes it float.

Lines of a Ship and Midship Sections and Offsets

Terms and Definitions Pertaining to Lines of a Ship

Every stagebuilder and carpenter should be familiar with the technical names denoting ship lines, surfaces, and dimensions. Familiarity with these terms is essential in reading blueprints and in building and installing parts of a ship.

LINES DRAWING — A plan showing, in three views, the moulded surface of the vessel. See Fig. 33.

MOULDED SURFACE — The inside surface of the skin, or plating, of a ship. The moulded surface has no thickness, and is fair and smooth.

Actually, when the ship has been built, the thickness of the plating will extend outside of the moulded surface. "Outside" strakes of plating do not touch the moulded surface if they have a liner against the shell frame. The *heel* of each shell frame is in this moulded surface (unless joggled). It should be remembered that this moulded surface is not an actual part of the ship. It is almost exactly the shape which a thin piece of sheet rubber would take if stretched tightly over the shell frames and main deck beams with no plating in place. See Fig. 34.

BASE LINE — A straight horizontal line at or near the bottom of the *moulded surface* from which vertical heights are measured. Usually, the base line is the very lowest part of the moulded surface.

WATERLINE — The intersection of the moulded surface with a horizontal plane at a given height above the base line. The six foot water line is exactly six feet higher than the base line. See Fig. 35.

These intersections are shown in the half breadth plan in the lines drawing. They should not be confused with the "load line" marked on the outside of a ship when built.

Stage builders and carpenters use a waterline merely as a height above the base line and in this sense waterlines are marked on bulkheads, frames, and other members, for the purpose of properly setting and aligning the structure.

CENTER LINE — A straight line running from bow to stern, midway between the sides of the ship. All transverse horizontal dimensions are taken from the center line. The center line as applied to a transverse bulkhead is a vertical line in the middle of the ship. See Fig. 34.

BUTTOCK — The intersection of the moulded surface with a vertical plane at a given distance from the centerline of the ship. Buttocks are shown in the profile in the lines drawing.

Stage builders and shipfitters use a butttock merely as a distance from the centerline. Thus, they have buttocks marked on bulkheads, decks, foundations, etc., for setting and alignment. The buttocks and the water-

lines which are marked on the steel members for regulating and setting are usually of some dimension expressed in even feet. That is, they would mark the 10′-0″ W. L. (Waterline) and the 24′-0″ Btk. (buttock) rather than a 10′-7″ W. L. or a 23′-6″ Btk. See Fig. 33.

Frame Line — The intersection of the moulded surface with a vertical plane perpendicular to the centerline transverse plane. Frame lines are shown in the body plan of the lines drawing. They get their name from the fact that shell "frames" or ribs usually are made to this shape and installed transversely in the ship. The lines drawing consists of three views; a half-breadth plan, a profile view, and a body plan. See Fig. 33. These views each show only one side of the ship (usually, the port side), because all dimensions for the starboard are equal and to the opposite "hand"; that is, the ship is symmetrical about the center line.

Profile — A view looking at the moulded lines from starboard to port. The waterlines and the frame lines are straight when observed from this direction. The deck line, or "sheer" curve shows up clearly in the profile, which for this reason is sometimes called the sheer plan. See Fig. 33.

Body Plan — A view showing the shapes of the frame lines. The body plan is made in two parts. The right-hand part is a view looking directly aft at the for'd port side of moulded surface, while the left-hand part is a view looking directly forward at the after half of the port side. This arrangement prevents the frame lines at the after end from obliterating or fouling the frame lines at the forward end. This view shows buttocks and waterlines straight, while the frame lines appear in their true shape. See Fig. 33.

Half-Breadth or Waterline Plan — A view looking down on the moulded surface. Here the frame lines and buttocks appear straight, while the waterlines show their true shape. To save space, only the port side is shown.

Load Waterline (L. W. L.) — The waterline at which the ship will float when loaded to its designed draft.

Forward Perpendicular (F. P.) — A vertical line at the point where the load waterline crosses the foremost part of the moulded surface.

After Perpendicular (A. P.) — A vertical line usually at the after end of the rudder post. If there is no rudder post, it usually is taken at the center of the rudder stock.

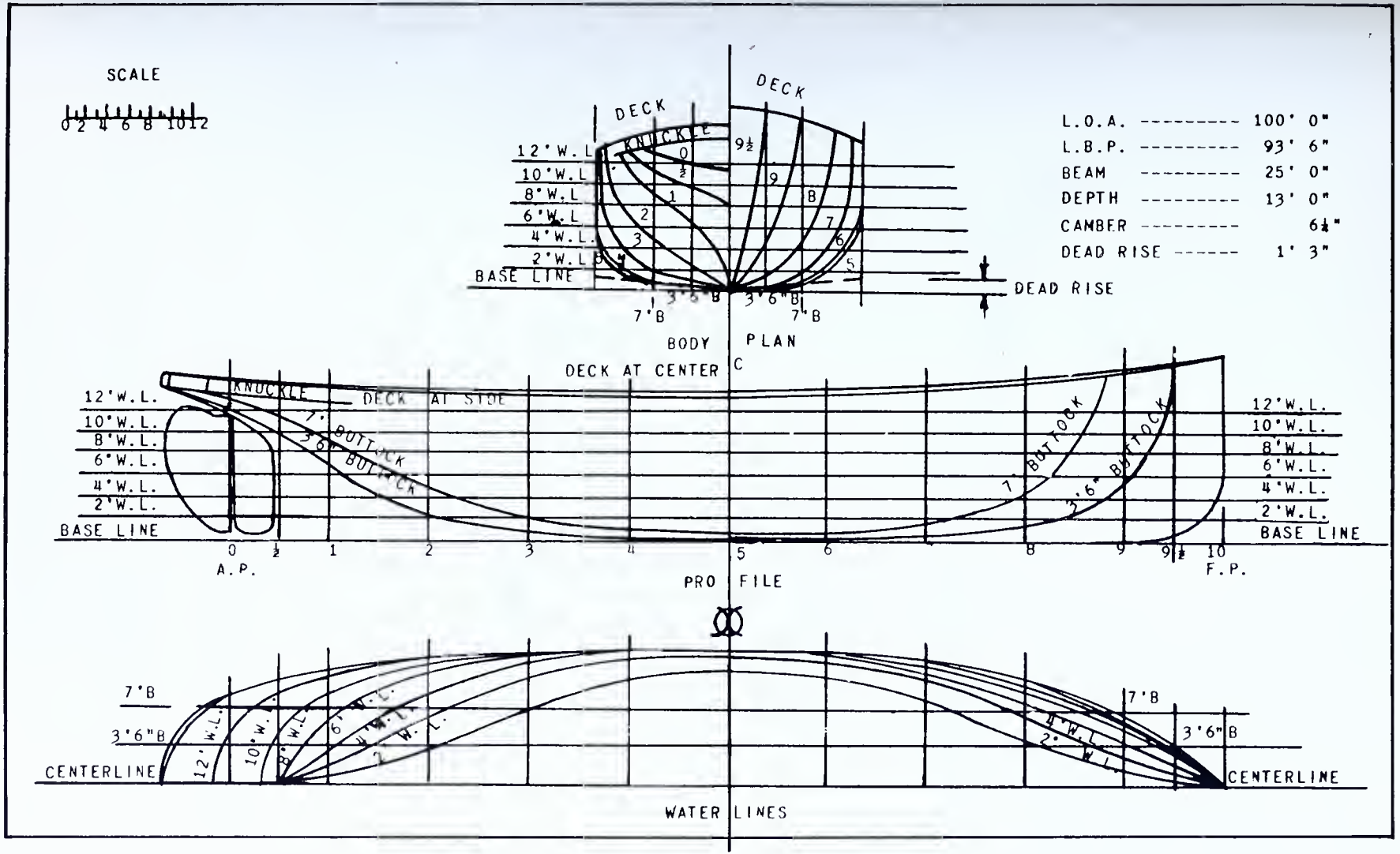


FIG. 33 — *"Lines Drawing"*

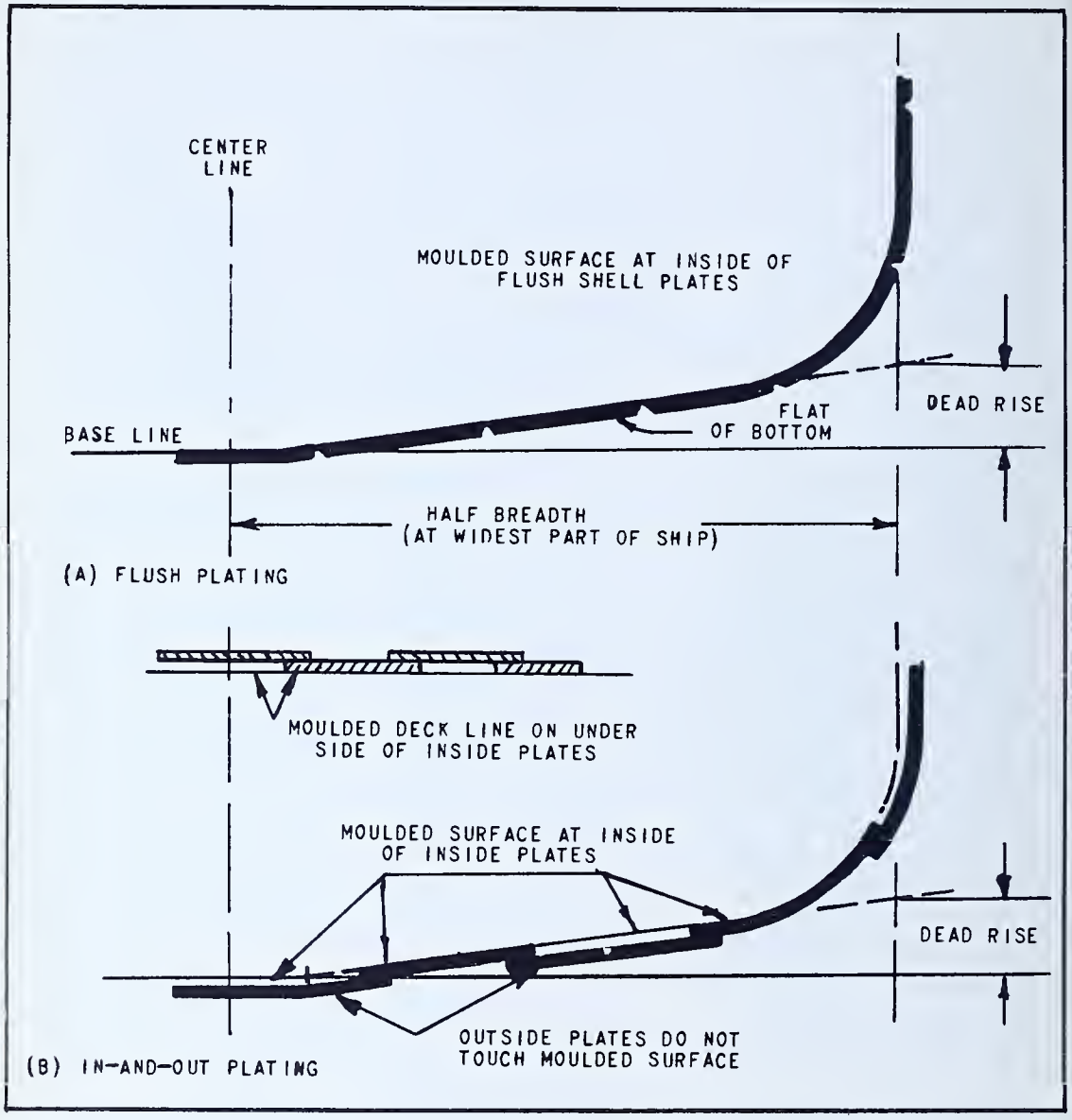

CENTER LINE
MOULDED SURFACE AT INSIDE OF FLUSH SHELL PLATES
DEAD RISE
FLAT OF BOTTOM
BASE LINE
HALF BREADTH (AT WIDEST PART OF SHIP)
(A) FLUSH PLATING
MOULDED DECK LINE ON UNDER SIDE OF INSIDE PLATES
MOULDED SURFACE AT INSIDE OF INSIDE PLATES
DEAD RISE
OUTSIDE PLATES DO NOT TOUCH MOULDED SURFACE
(B) IN-AND-OUT PLATING

FIG. 34 — *Moulded Surface*

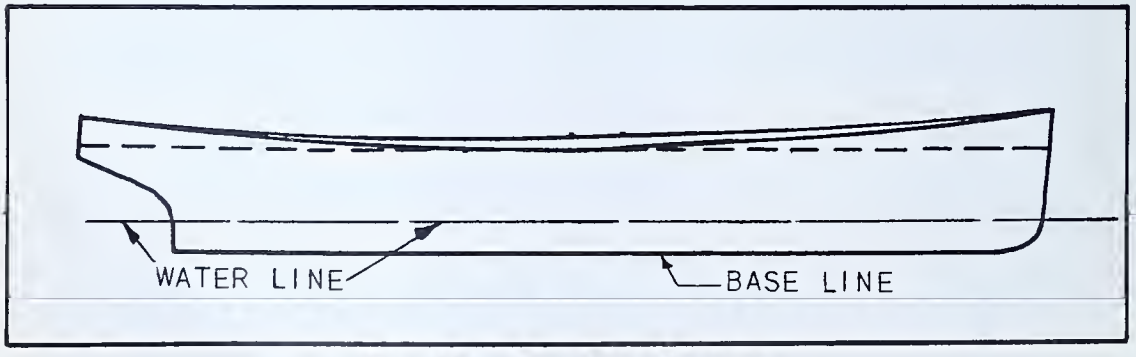


FIG. 35 — *Base Line Location*

LENGTH BETWEEN PERPENDICULARS (L. B. P.) — The distance from the forward perpendicular to the after perpendicular. To the designers, this length is very important, since upon it largely depends the amount of power needed to drive the ship.

LENGTH OVER ALL (L. O. A.) — The total length of the ship from one end to the other, including bow and stern overhangs.

MIDSHIP SECTION — A transverse section exactly half way between the F. P. and the A. P. Almost invariably, this is the widest part of the ship. See Fig. 33.

PARALLEL MIDDLE BODY — The straight part of the center of the ship where the water lines and buttocks have no curvature; that is, where all the fore and aft lines are parallel.

DEADRISE — The rise of bottom. It is the difference in height between the base line and the point where the straight line through the bottom flat surface intersects the vertical line through the side of the moulded surface at its widest point. (See A and B in Fig. 34, also Fig. 36).

BEAM — The width of the ship (moulded surface) at the widest point. See Fig. 36.

DEPTH — The height of the ship at the midship section from the base line to the moulded line of the deck at side (underneath).

DRAFT (Moulded) — The height from the base line to the load water line.

FREEBOARD (Moulded) — The difference between the moulded depth and the moulded draft. (It is the height of the side of the vessel which is above the water when it floats at the load water line).

CAMBER — The curvature of the deck transversely. It is measured by the difference in height between the deck at center and the deck at side. See Fig. 36.

TUMBLE HOME — The amount the top of the side shell slopes back toward the centerline between the point at the widest breadth and the deck at the top side. See Fig. 36.

SHEER — The curvature of the deck at side as shown in the profile. The amount of sheer forward is the difference in height between the deck line (at side) amidships and the deck line at the forward end. See Fig. 37.

The amount of sheer aft is the difference in height between the deck (at side) amidships and the deck at the after end. The line of the deck at

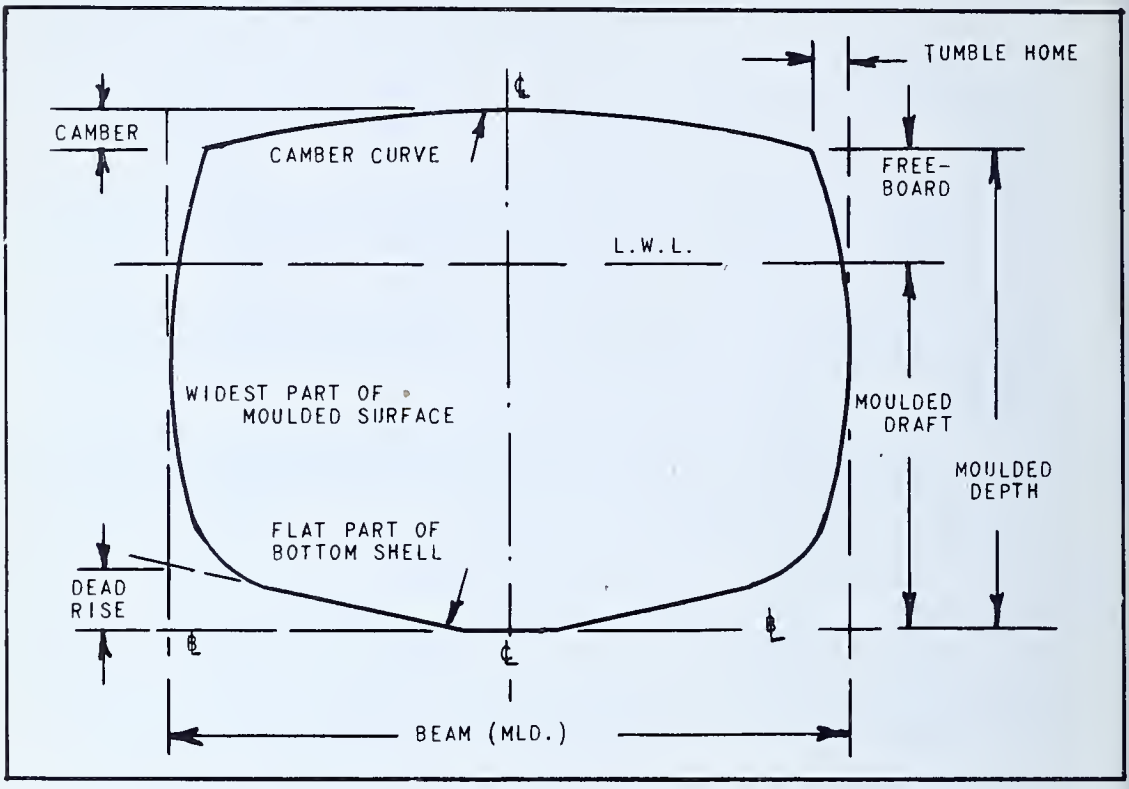


FIG. 36 — *Moulded Dimensions at Midship Section*

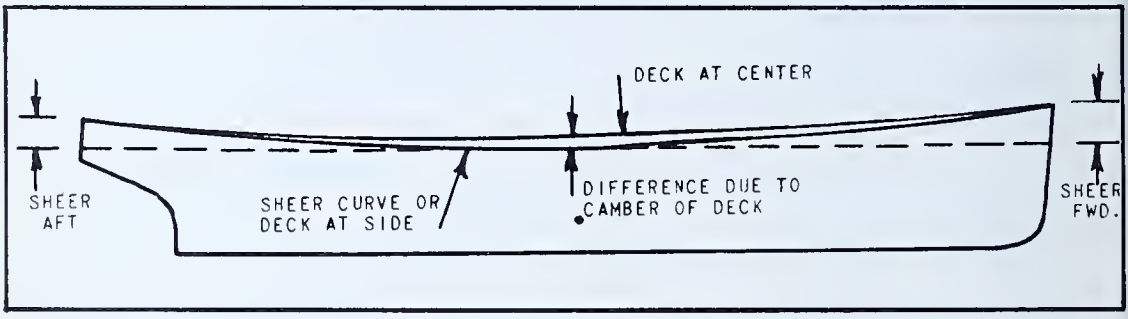


FIG. 37 — *Sheer Curve*

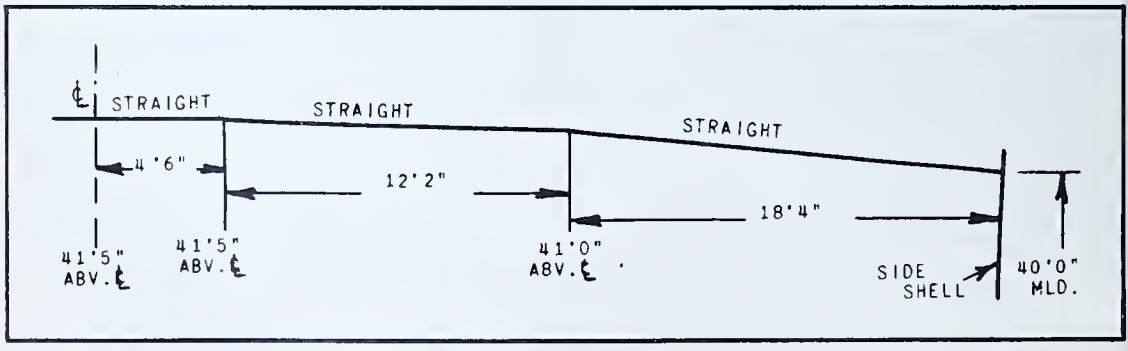


FIG. 38 — *Camber Curve — (Composed of Straight Lines)*

center, in the profile, is higher than the line of the deck at side, owing to the camber, or transverse curvature of the deck.

In Fig. 37 is illustrated the difference between the deck at the side and the deck at the center, owing to camber. The camber curve, as usually designed, is a circle of very large radius, but sometimes it is made as a series of straight lines, as in Fig. 38.

The camber curve is the moulded line of the deck.

Midship Section and Offsets

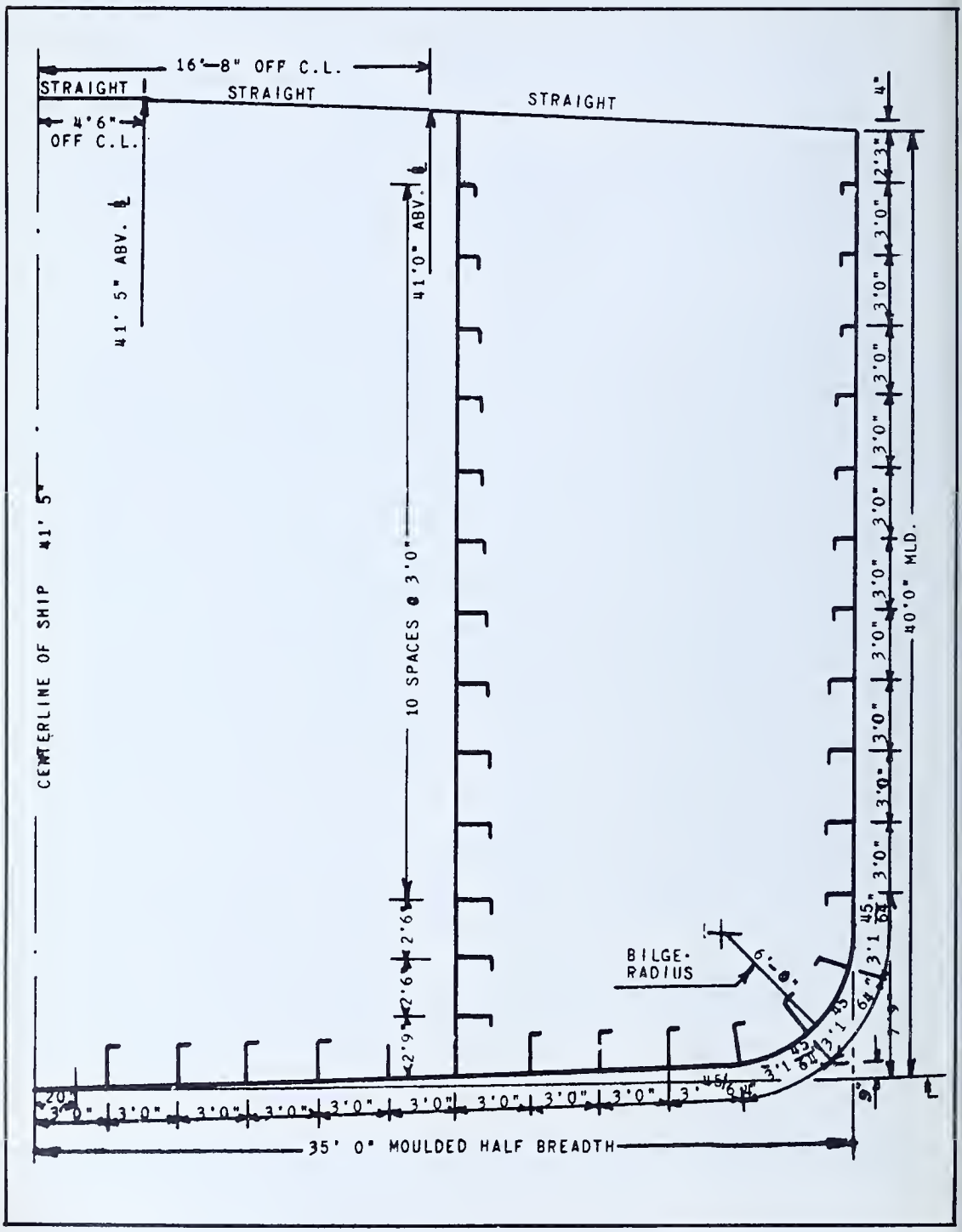
The midship section of a ship, as stated before, is a transverse section taken halfway between the forward perpendicular and the after perpendicular. Figure 39 shows the midship section of one type of oil tanker, giving the outline of the moulded surface at this section and also the spacing of the shell longitudinals and the longitudinal stiffeners.

The camber of the deck is shown, as well as the deadrise and the bilge radius. This shape and spacing applies throughout the parallel middle body of the vessel (in this example, from frame 26 to frame 44).

As illustrated, the shell longitudinals are three feet apart except for one space at the top of the side shell and four spaces in the bilge. The longitudinal bulkhead stiffeners are three feet apart except for three spaces at the bottom. The deadrise is nine inches. The moulded beam is seventy feet. The moulded depth is forty feet. The bilge radius is six feet. The camber of the deck is 1′5″ in straight lines. There is no tumble home.

The stiffeners (longitudinals) heel inboard on the bottom shell and upward on the side shell and longitudinal bulkhead. In Fig. 39 are given the midship section offsets for this tanker. Offsets are measurements of distance from the base line or from the centerline to any point in the moulded surface. Half-breadths are measured transversely from the centerline. Heights are measured vertically from the base line. From the table of half breadths, we see that at frame 26, the 8 foot waterline is exactly 35 feet from the centerline. The 2 foot waterline is only 32′ 9¾″ from the centerline at this frame. (The offset 32-9-6 means 32 feet—9 inches—6 eighths of an inch, or 32 feet 9¾″).

From the table of heights, we see that at frame 44 the four foot buttock is only ⅝ of an inch above the base line, and the 24 foot buttock is 6⅛ inches above the base line. These midship section offsets apply from frame 26 to frame 44, which is the extent of the parallel middle body.


16'-8" OFF C.L.
STRAIGHT
STRAIGHT
STRAIGHT
4'6" OFF C.L.
41' 5" ABV. ℄
41'0" ABV. ℄
CENTERLINE OF SHIP 41' 5"
10 SPACES @ 3'0"
2'6"
2'6"
2'9"
40'0" MLD.
4"
12'3"
3'0"
BILGE RADIUS
6'-0"
3'1 45/64"
3'1 43/64"
3'1 45/64"
3'0"
3'0"
3'0

side. The heights of the 3′ 6″ and 7′ 0″ buttocks are also given for each frame station from No. 0 to No. 10.

Midship Section Offsets

HALF-BREADTHS ON WATERLINES AND DECKS					
Frame	2'W.L.	4'W.L.	8'W.L.	12'W.L.	16'W.L.
26-44	32-9-6	34-4-5½	35-0-0	35-0-0	35-0-0
Frame	20'W.L.	24'W.L.	28'W.L.	32'W.L.	36'W.L.
26-44	35-0-0	35-0-0	35-0-0	35-0-0	35-0-0

HEIGHT ON BUTTOCKS & DECKS					
Frame	4'Butt	8'Butt	12'Butt	16'Butt	20'Butt
26-44	0-0-5	0-1-6	0-2-6½	0-3-7½	0-5-0
Frame	24'Butt	32'Butt	UPDK-SIDE	UPDK C. Line	
26-44	0-6-1	1-5-3	40-0-0	41-5-0	

Plumbing

It is important that the mechanic responsible for plumbing and aligning should understand the fundamental principles of declivity.

The plumb bob when suspended by a string and allowed to come to rest will form a plumb or vertical line. When doing outside work, the mechanic should use a plumb bob of sufficient weight that air currents cannot move it and so disturb the accuracy of the line.

The plumb bob is the most accurate method of plumbing long vertical members. When the stage builder or shipwright is plumbing a bulkhead, the plumb line can be hung on a vertical stiffener at the after side of the bulkhead, and the vertical height "h", Fig. 40, measured from the top to the point where the measurement "d" is taken. This height (in feet) multiplied by the declivity of the shipway (in inches per foot) will give the required dimension "d" in inches. This dimension "d" is measured from the vertical stiffener to the plumb line and at right angles to the bulkhead.

If the plumb line cannot be hung on the after side of the bulkhead, it can be arranged on the forward side as shown at "e" and "f" in Fig. 40. The plumb line is hung forward from the top of the bulkhead from any available support, and the distances "f" and "e" are measured. Then, "f" minus "e" will equal "j" (in feet) multiplied by the declivity of the shipway (in inches per foot). The bulkhead must be moved until the equality mentioned above is attained.

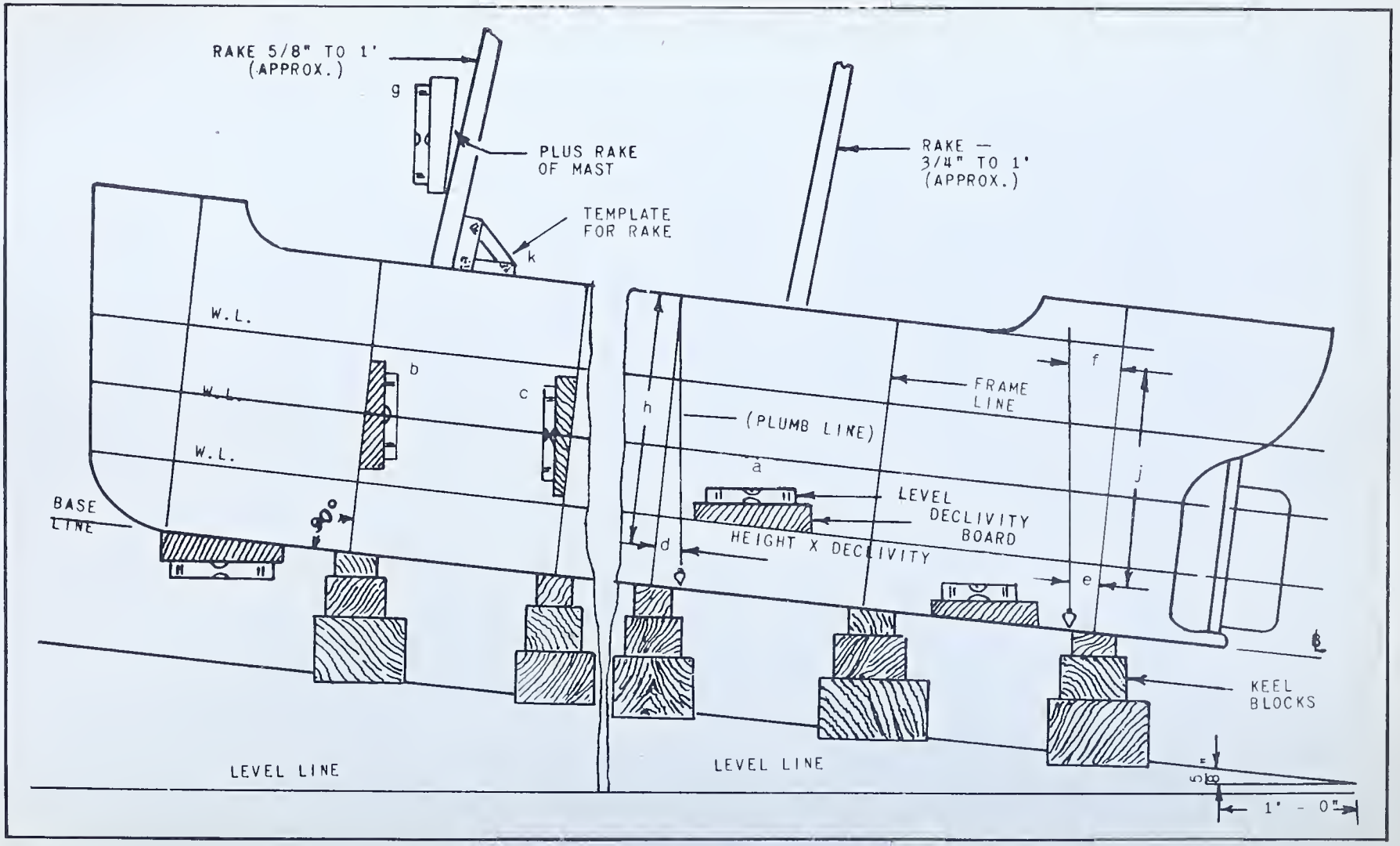


FIG. 40 — *Leveling and Plumbing of Ship During Construction*

Figure 41 shows how the plumb bob is used in plumbing a bulkhead transversely. The plumb bob is hung at any convenient distance from the center line at the top of the bulkhead. A line "ab" is drawn on the tank bottom at this same convenient distance from (and parallel to) the center line of the ship. The bulkhead must be adjusted until the plumb bob falls on the line "ab".

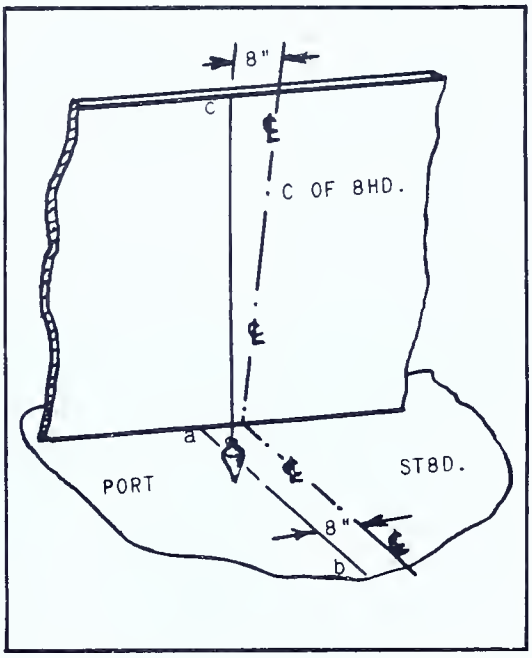


FIG. 41 — *Plumbing a Bulkhead Transversely*

Declivity

The slope of a shipway is called the declivity. Shipways are built on declivity so that the ship will slide from the ways because of its own weight. Declivity is expressed as a certain rise in inches per horizontal foot, as shown in Fig. 42. The rate of rise of the line "ab" is such that for every foot along the level "bc" the vertical rise of the sloping line is 5/8". Usually the bottom of the ship's keel is parallel to the base line of the ship, although this is not always true. The tops of the keel blocks must be set to a line which has the same declivity as the shipway. The base line and all the water lines of the ship will then be parallel to the line of the keel blocks and will have the same declivity as the shipway. The frame line of the ship will be at right angles to the base line. Figure 40 illustrates how levels, declivity boards, and plumb lines are used in plumbing, aligning, and testing ship members.

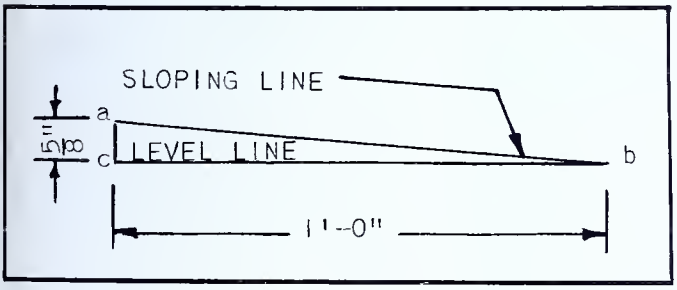


FIG. 42 — *Declivity Per Foot*

In the Sun Shipbuilding Yard, shipways number 1, 2, 8, and 9 to 20 have a declivity of 5/8" per foot. Shipways number 3, 4, 5, 6, and 7 have a declivity of 11/16" per foot.

Use of the Declivity Board

A declivity board (Fig. 43) is an accurately planed board, the two opposite edges of which are not parallel, but form an angle which is the same as that of the slope of the shipway. When the top edge of the board is made horizontal by means of an ordinary carpenter's level, as shown at "a" in Fig. 40, the bottom edge of the board is used to test the declivity of water lines, base lines, etc., in a fore-and-aft direction. It is also used to plumb stanchions longitudinally. The declivity board is not used when leveling transversely, since there is no slope in that direction.

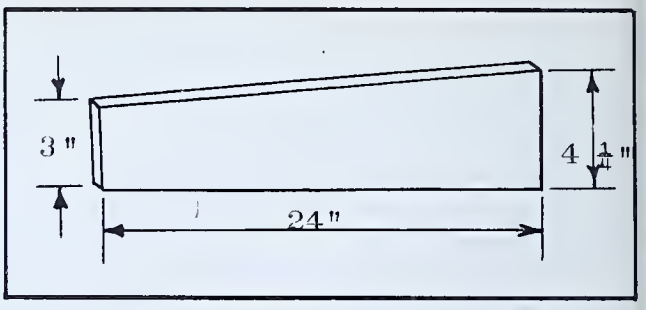


FIG. 43 — *Declivity Board*

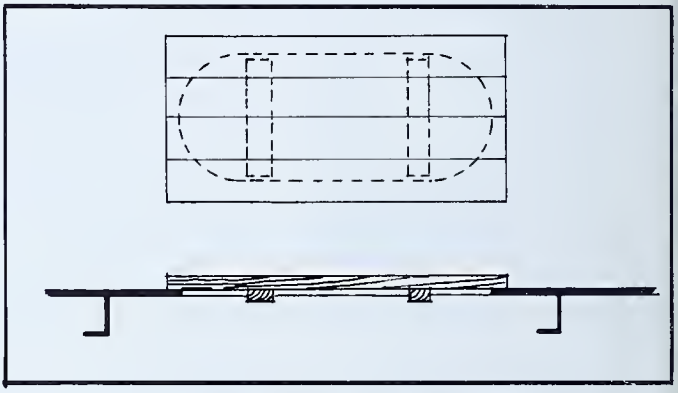


FIG. 44 — *Box Guard for Small Openings*

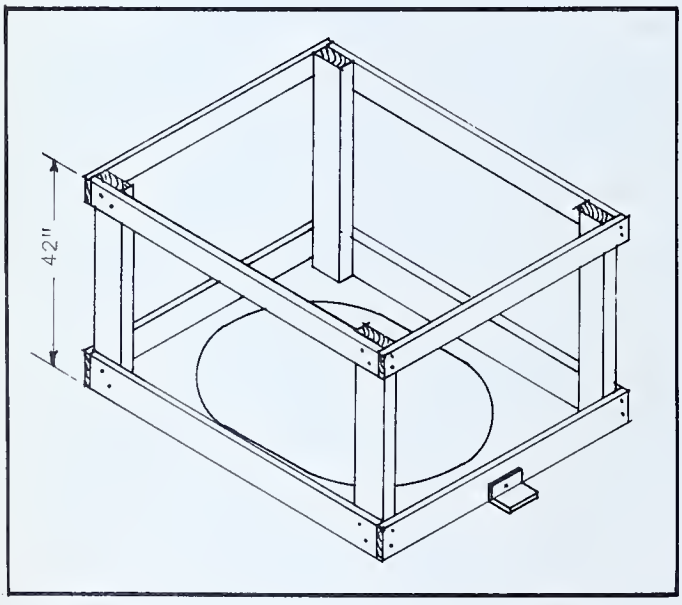


FIG. 45 — *Guardrail for Large Opening*

Frames and transverse bulkheads are perpendicular to the base line or the bottom shell; thus declivity may be tested as shown at "b" in Fig. 40, using the level and declivity board in a vertical position. By turning the declivity board end for end, the forward side may be tested as shown at "c".

Since a ship on the ways has declivity in a fore-and-aft direction only, it is imperative that the level be held parallel to the center line of the ship when used with a declivity board. When leveling transversely, no declivity board is used; the level must then be held at right angles to the center line of the ship, that is, parallel to the frame lines.

Types of Guardrails

The use of guardrails in ship staging is an important item. There was a time when the guardrail was considered unnecessary; however, it is now considered a vital factor of safety. A safety man is continually walking about the ship looking for unguarded openings and passageways. His duty is to see that proper safety measures are observed for the protection of workmen.

Each flight of staging more than 12 feet above the shipway must have a guardrail. All openings in the deck, cargo hatches, and the sides of the top deck must have railings. The casings in the boiler rooms and engine rooms must have a guardrail around each flight of staging. If the laying of a deck is unfinished, a guardrail must be placed; in fact, any working space from which men may fall must be guarded with a rail. A temporary guardrail (Fig. 47) is always placed along all open stairways, since the pipe railings are not placed until the ship is nearly complete. Furthermore, walkways from the staging to the ship must

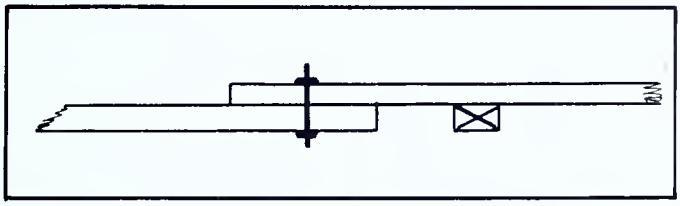


FIG. 46 — *Method of Joining Guardrails*

FIG. 47 — *Guardrails in Place*

be guarded. The many small openings in the deck must be protected by guardrail or wood covers to prevent workers from walking into them. The cover type of guard, as shown in Fig. 44, is used for this purpose. It is made from 1½″ x 10″ boards and 1¼″ x 5″ battens nailed together. Many of these covers are constructed before the boat is begun so that they may be placed as they are needed. This type of cover guard is used particularly to cover small deck openings. Larger openings are cared for by the method shown in Fig. 45.

It is important that guardrails are of the proper height. The proper height is 40″; a 36″ rail is too low. Long guardrails made up of short lengths of rail stock are bolted together as shown in Fig. 46.

Approximately 400 pieces of 3″ x 5″ x 18′-0″ guardrail are needed to guard one ship properly. New, straight-grained lumber should always be used. All guardrail should be surfaced on four sides, and the top edges should be chamfered.

Ropes and Knots

Rope is used extensively in staging for repair work and in lowering and lifting staging from tanks. Rope may be made from vegetable fibers or from metallic wires. Vegetable fiber rope is used by the stage builder.

Manila fiber is secured from the wild banana plant which grows in the Philippines. The fiber is stripped from the leaf stems contained in the trunk. Climatic and soil conditions plus the degree of care exercised in the fabrication determine the grade of the fiber.

Manila is the most important rope-making material. It has a light-straw, smooth, glossy appearance and has a tensile strength of 30,000 lbs. per square inch. The fiber is round, easily separated, and very light. The length of fibers is from 6 to 10 feet.

A *yarn* or thread is a number of fibers twisted together, usually in a right-hand manner.

A *strand* of rope is two or more yarns twisted together. This twist is usually in the opposite direction to the twist of the yarns.

The whole principle of rope making depends upon this opposing of twists. The yarn tends to unlay, but as it is laid up on an opposite twist in the strand the two tendencies counteract each other. The mutual friction formed by overlapping fibres and twisting gives the rope strength. Hard twisting increases this friction, compacts the fibres, and makes the fibres less likely to absorb moisture.

Care of Rope

Proper handling and care increase the life of rope. Although Manila rope deteriorates very little from wetting, rope should never be put away while it is wet or damp. After rope has been used, it should be cleaned, rolled into a

loose coil, and dried. Rope should be stored in a well ventilated place to insure free circulation of air.

APPROXIMATE GROSS WEIGHT AND STRENGTH PLYMOUTH MANILA ROPE

Common Lay Three Strand

CIRCUMFERENCE	DIAMETER (NOMINAL)	LENGTH AND WEIGHT (APPROXIMATE) STANDARD COIL		MINIMUM TENSILE STRENGTH NEW MANILA ROPE LABORATORY TEST	FEET PER POUND (MINIMUM)
Inches	Inches	Feet	Pounds	Pounds	
12 thd. 1⅛	⅜	1,450	50	1,275	29.0
21 thd. 1½	½	1,200	90	2,650	13.3
33 thd. 2¼	¾	1,200	200	5,400	6.00
3	1	1,200	324	9,000	3.71
3¾	1¼	1,200	502	13,500	2.40
4½	1½	1,200	720	18,500	1.67
5½	1¾	1,200	1,073	26,500	1.12
6	2	1,200	1,290	31,000	.930

(*Courtesy Plymouth Cordage Co.*)

The Bowline Knot

The art of knotting and splicing cannot be learned entirely from books. The sketches and descriptive material will be understood more clearly when the various knots are demonstrated by an instructor.

The bowline knot is in common use because it will neither slip nor joint if properly made. To make the knot, take the bight of the rope in the right hand. Place the end of the rope over the standing part to form a small loop or gooseneck in the bight of the rope, as shown in the first sketch in Figs. 48 and 54. Bring the free end of the rope through the small loop and

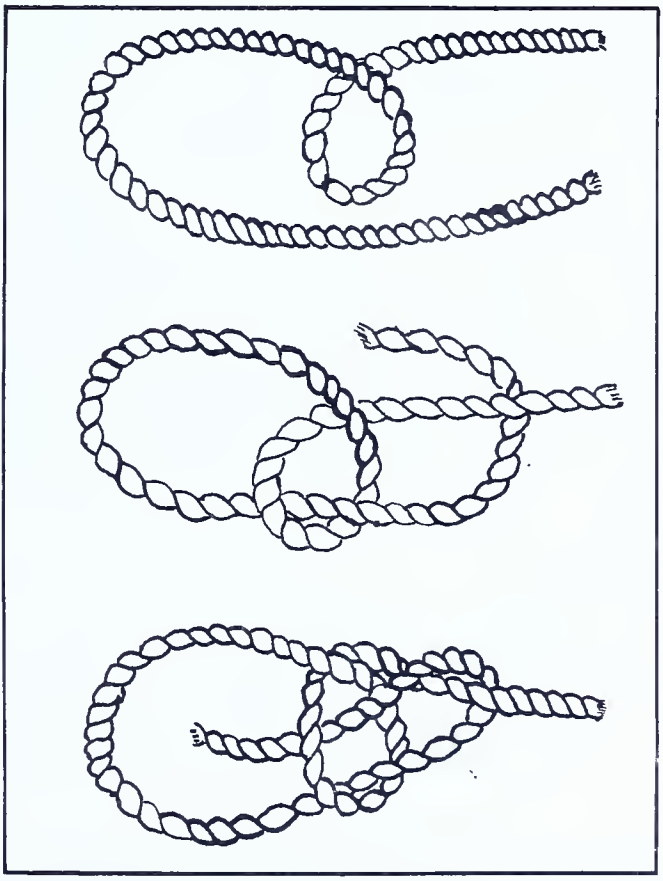


Fig. 48 — *Tying a Bowline Knot*

down around under the standing part of the rope. Finish the knot by carrying the end up over the standing part and back through the gooseneck. See Fig. 48.

Running Bowline

The running bowline knot serves as an excellent slip knot; it slips freely and cannot jam or unfasten. It is actually a simple bowline with the long end or standing part of the rope passed through the larger loop. See Fig. 49.

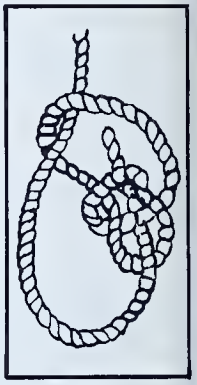


Fig. 49—*Running Bowline*

Half Hitch

The half hitch may be made in a variety of ways: the single half hitch, two half hitches, or a round turn and two half hitches. The knot is used for making fast the end of the rope; it should never be used for hoisting because it will slip. The knot is very simple to tie. See Fig. 50.

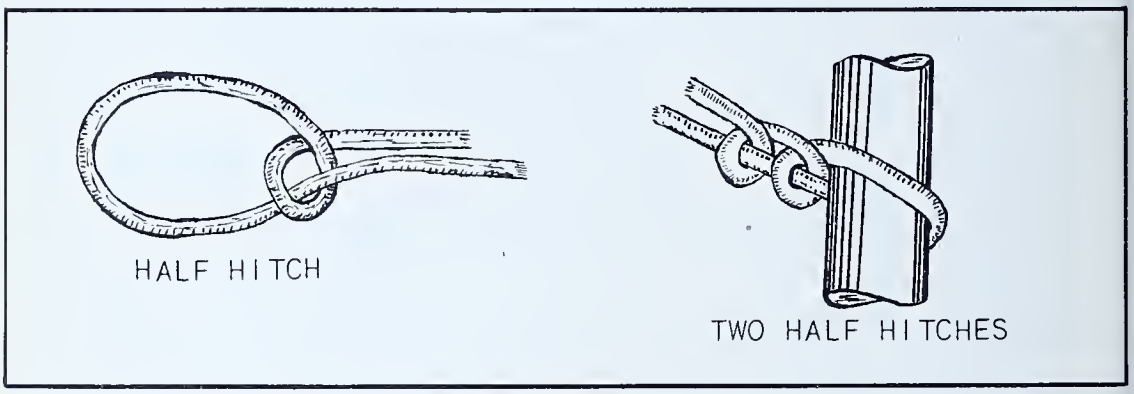


Fig. 50

Timber Hitch

The timber hitch is commonly used for towing; a combination timber and half hitch is used when raising or lowering planks. The half hitch acts as a lock and prevents the opening of the timber hitch. See Fig. 51.

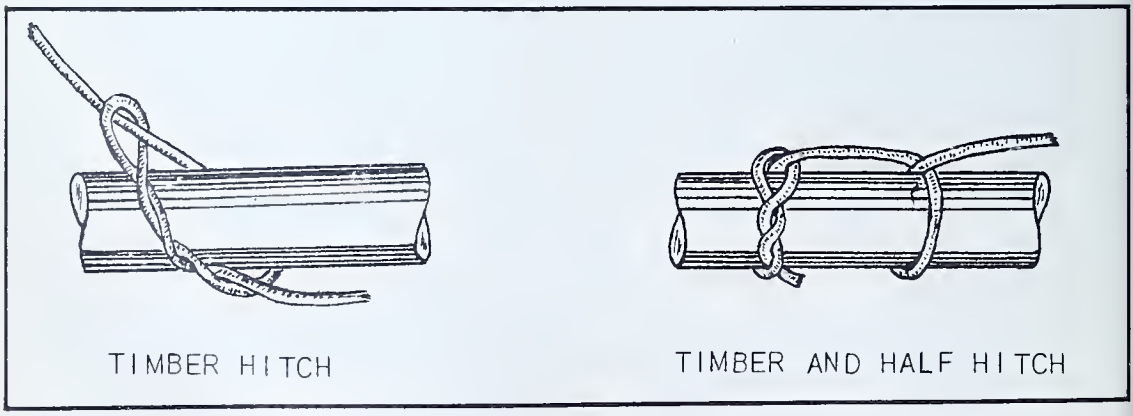


Fig. 51

Clove Hitch

A clove hitch is used to fasten a rope to a spar at an angle or to start a lashing. When used for securing guys, shear legs, etc., the knot should be made with a long end, that is, formed into two half hitches around the standing part and then seized to it. If no free end of the rope is available, make a hitch as shown in Fig. 52 and slip it over the end.

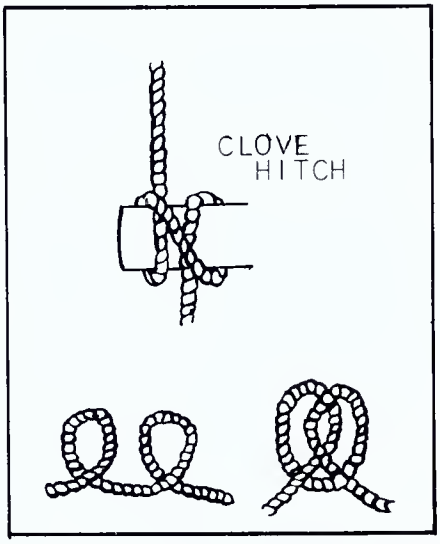


Fig. 52 — *Making a Clove Hitch*

Whipping Rope End

In whipping a rope, the workman places the end of the twine in the depression between two of the strands and makes one or two turns around the rope to hold the twine in place. Then the main part of the yarn, "a" (Fig. 53), is laid lengthwise along the rope, forming a long loop, one part of which, "b", is held tight and wound around both the rope and the yarn until a sufficient number of turns has been made. Then, pulling the whipping makes the whole tight and secure. The ends may then be cut off close to the rope.

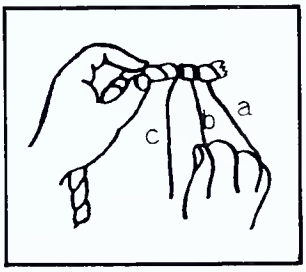


Fig. 53 — *Whipping Rope End*

Bowline on a Bight, or Double Bowline

The bowline is used when a loop is desired in the middle of a rope. It is especially useful for forming a seat for men or a loop for lifting materials. See Fig. 55. To tie this bowline, take the bight of the rope and proceed the same as with the simple bowline. However, instead of tucking the end down through the bight of the knot, carry the bight over the whole and draw up so as to make it double in the knot and double in the standing part. The loop under the standing part is single.

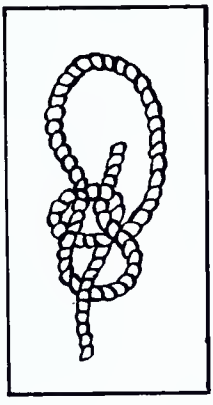


Fig. 54— *Simple Bowline Knot*

Figure Eight Knot

This knot is used to prevent unreeving or to prevent the rope ends slipping through a block. It is made around the standing part in a second loop and then back through the first loop. See Fig. 56.

Reef Knot

This is commonly used to join two ropes of the same size. A reef knot is strong; the harder the pull the more firmly it holds. However, a reef knot

joining two ropes of unequal sizes is likely to slip. It is easily tied by passing the standing and running parts of each rope through the loop of the other in the same direction; i. e., from above downward, or vice versa. See Fig. 57. A reef knot may be upset by pulling the standing and running parts of the same piece of rope in opposite directions.

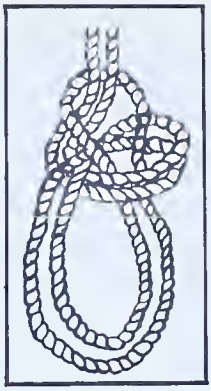


Fig. 55 — *Bowline on a Bight or Double Bowline*

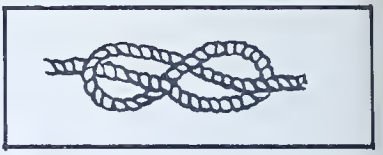


Fig. 56 — *Figure Eight Knot*

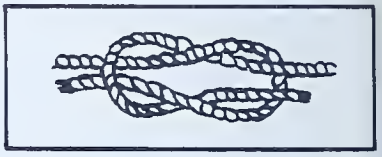


Fig. 57 — *Reef Knot*

Overhand Knot

This is used at the end of a rope to prevent it from unreeving or to prevent the end of a rope slipping through a block. See Fig. 58. It is tied by making a loop of the rope with the short end of the rope passing over the main rope down through the loop. The knot is then pulled tight. The objection to this knot is that it is difficult to untie.

Fig. 58. *Overhand Knot*

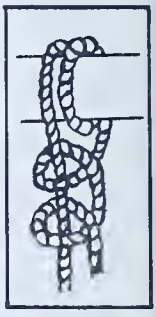


Fig. 59 *Round Turn With Double Half Hitch*

Round Turn With Double Half Hitch

This is used for belaying or making fast the end of the rope around its own standing part. The end may be seized to the standing part to prevent slipping. This knot should never be used for hoisting a spar. Fig. 59 shows a round turn in connection with the double half hitch.

Scaffold Hitch

This is used for slinging scaffold so that it will not turn in the sling. It is started by making a clove hitch with the two free ends of the rope below the scaffold. See Fig. 60. Then, each rope is drawn back on itself and up over the opposite sides of the board, where the short end is joined to the other with a bowline knot. Another way of making the hitch is to wrap the rope around the scaffold plank so that it crosses the top of the plank three times.

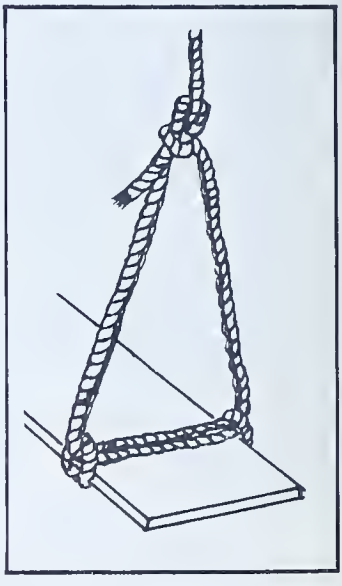


Fig. 60 — *Scaffold Hitch*

The middle loop is then pulled down so that it folds over the end of the plank. This hitch is completed by attaching the free end of the rope to the standing part with a bowline knot.

Efficiency of Various Hitches and Knots

The size of the rope used is determined by the size of the job to be done. The table on page 43 gives the safe working load of various sizes of rope. However, the percentage of efficiency drops quickly when a knot is tied in a line. The table shown below gives the different percentages of efficiency when rope is used with splices and knots.

DECREASE OF STRENGTH OF ROPE WHEN KNOTTED OR SPLICED

Full strength of dry rope	100 per cent efficiency
Eye splice over iron thimble	90 per cent efficiency
Short splice in rope	80 per cent efficiency
Timber hitch, round turn, half hitch	65 per cent efficiency
Bowline, slip knot, clove hitch	60 per cent efficiency
Square knot, weaver's knot, sheet bend	50 per cent efficiency
Flemish eye, overhand knot	45 per cent efficiency

Blackwall Hitch — Single

The blackwall hitch is used for attaching single rope to the hook of a block. It consists of a loop with the free end of the rope passing under the standing part and across the hook. See Fig. 61. This hitch will carry a heavy load, providing the tension is constant.

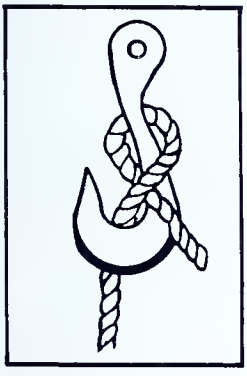


Fig. 61 — *Blackwall Hitch—Single*

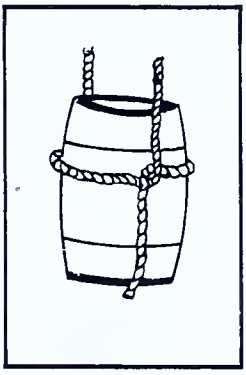


Fig. 62 — *Barrel Sling Vertical*

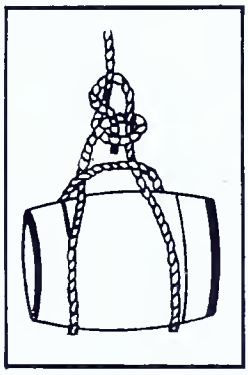


Fig. 63 — *Barrel Sling Horizontal*

Barrel Hitch or Sling

This hitch is used for hoisting barrels in either a vertical or horizontal position. It is similar to a running bowline. To sling a barrel vertically, make

an overhead knot on top of the two parts of the rope, open out the knot, and slip each half down the sides of the barrel and secure them with a bowline. See Fig. 62. To sling a barrel horizontally, the bowline is made with a long bight. See Fig. 63.

Gate Blocks and Wire Rope

A gate block opens at one side, making it easy to thread the block without running the end of the wire rope through the block. The block is locked in a closed position by a patent catch.

The gate block and wire rope rigging are largely used for dry dock repair work.

Power is obtained by wrapping from five to seven turns on the niggerhead of the winch and pulling on the loose end. The wire is wrapped around the niggerhead so that it leads off the top. When the winch head is rotated, pull the slack end of the wire tightly to the head, thus causing the wire to be pulled by the winch.

Eye Splice

Unlay the end of the rope for a sufficient distance to tuck three times. This distance will vary with the size of the rope. On large rope it is well to whip the ends, though a careful workman will not have to do this.

Decide upon the size of the eye; then bring down the crotch of the strands, and lay the middle strand up with a strand lying on either side. Hold the eye toward the body and tuck in the strands as follows:

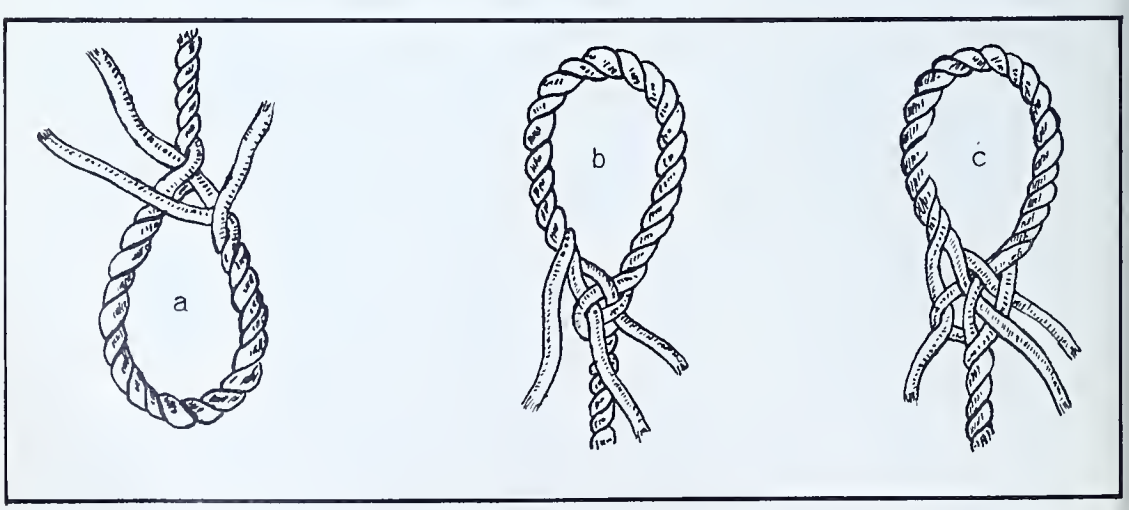


Fig. 64 — *Progressive Stages for Making an Eye Splice*

Middle strand under the strand immediately above it. Figure 64-"a".

Left-hand strand over the strand under which the first strand was tucked, and under the next. Fig. 64-"b".

Turn the splice over, give the last strand an extra twist with the lay, and tuck it under the remaining strand in the bight of the rope. All strands are tucked from right to left. Fig. 64-"c". Then tuck over and under two more times.

SHORT SPLICE

Unlay the ends of the ropes to be joined and crotch the ends. Fig. 65-"a". Stop down the end on one side against the bight and tuck the others over and under. Then turn around and tuck the other ends over and under from right to left. Fig. 65-"b". Tuck twice; then cut out strands for neatness, and tuck twice again on each side. Fig. 65-"c".

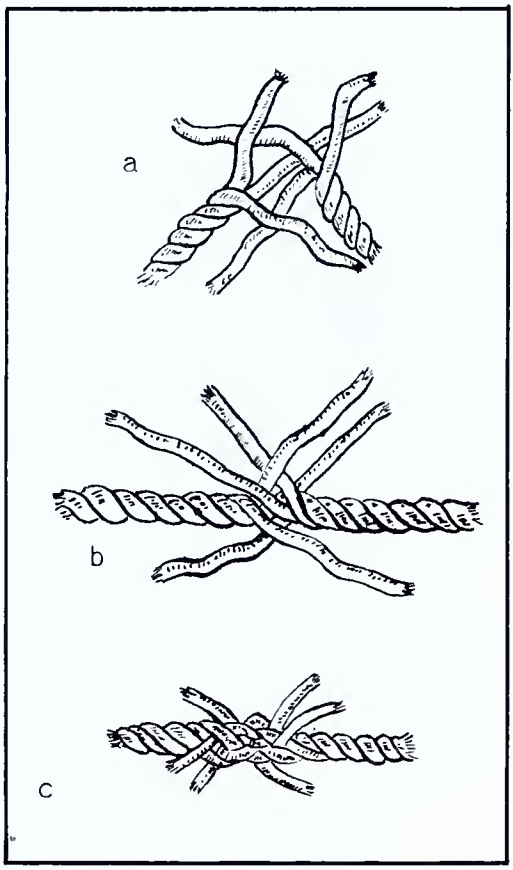


FIG. 65 — *Stages in Making a Short Splice*

Part IV
STAGE BUILDING PROCEDURES

JOB SHEET NO. 1
PLACING KEEL BLOCKS

General Information

The various blocks of wood which go to make up the keel block are cut from 12″ x 12″ timber. The particular names given to blocks are indicated in Fig. 66. Notice in the figure that the intermediate block is made of three pieces rather than of one solid piece. The block is made in this manner because it is too large to be cut from a solid piece, and furthermore it is necessary to run the grain of the wood at right angles to the grain of the base blocks.

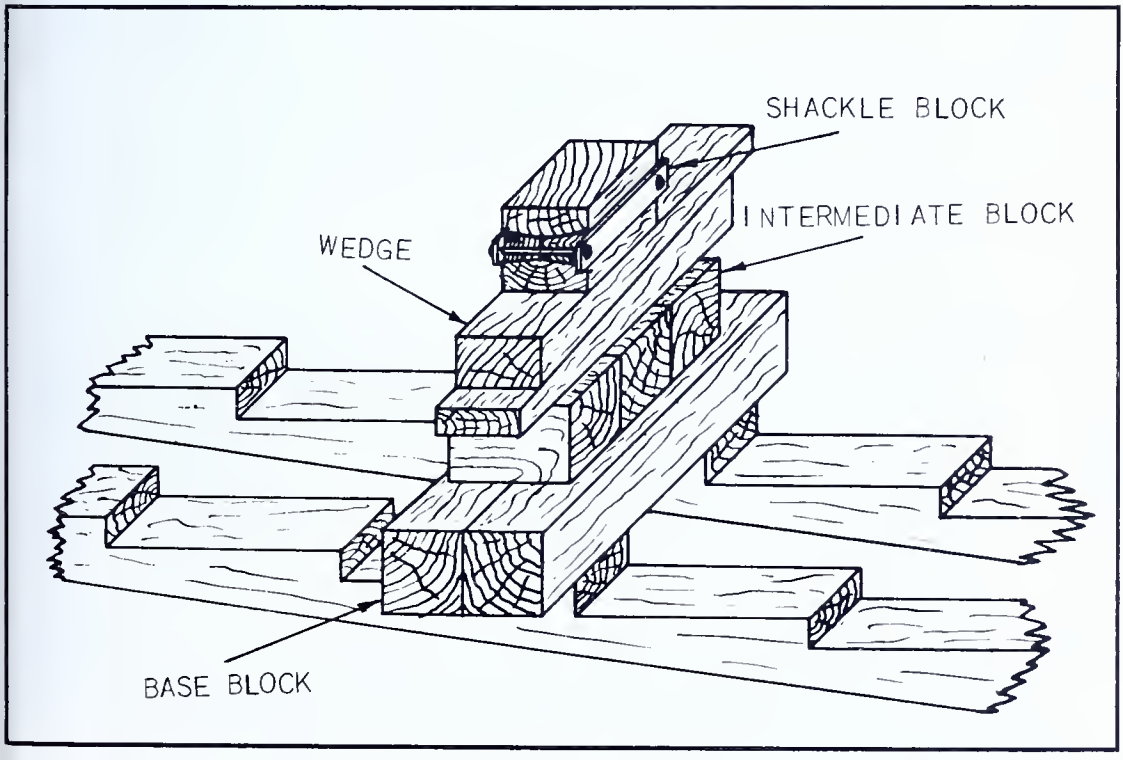


Fig. 66 — *Keel Block*

The filler block is not placed until the blocks are set to conform to the declivity line established by the surveyor.

Keel blocks are set a distance of 4 feet apart, and they are usually numbered so that they may be easily identified in case one should have to be removed.

Study the drawing of the keel block. Note particularly the names of the various blocks.

Special Safety Precautions

1. Use care in handling heavy blocks.
2. Wear gloves while handling the heavy wooden blocks. Gloves reduce the hazard of driving splinters into the hands.

Tools and Materials

1. Hatchet
2. Carrying hooks
3. Nail bar
4. Saw
5. Open-end wrench (1″)

Equipment

1. Crane which is used in placing the materials
2. One set of pennants
3. One pair of carrying hooks

Other Mechanic Needed: Carpenter.

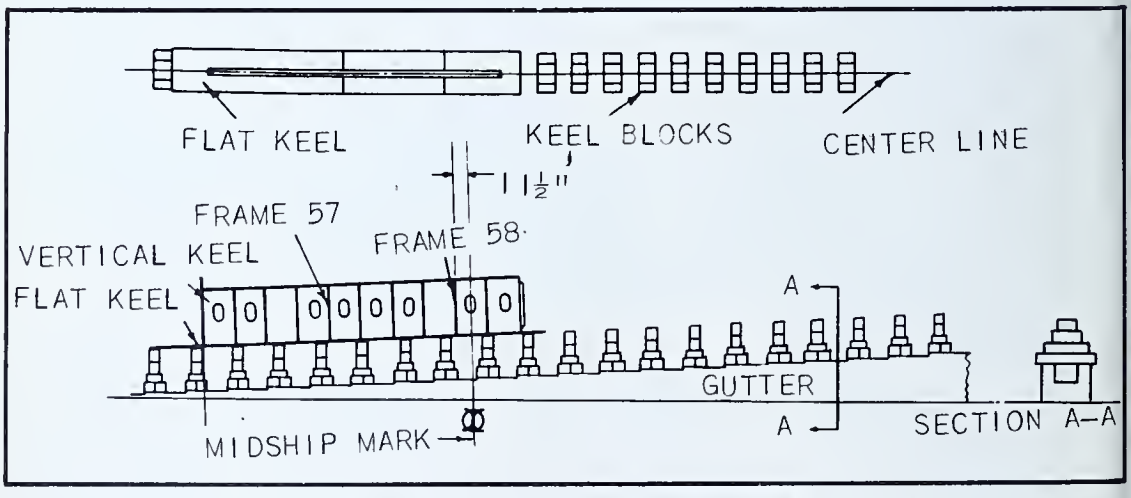


Fig. 67 — *Keel Blocks Aligned on the Gutter Walls*

Procedure

1. Set the two yellow-pine base blocks, 12″ x 12″ x 47″.

   These are placed side by side across the gutter and at the end of each step. See Figs. 66 and 67.

2. Place the 12″ x 18″ x 30″ intermediate block on top of the two base blocks, as shown in Fig. 66.

3. Set the pair of wedges.

   The wedges are cut from a piece of 12″ x 12″ timber. When placing the wedges, place the sloping sides, or the longest sides of the wedges, together. Placing them otherwise makes striking more difficult when driving the wedges into position.

4. Set the bottom block. See Fig. 66.

   The filler block is not placed at this time. Each filler block is measured, cut separately, and placed when the blocks are set to conform to the declivity line established by the surveyor.

5. Assemble and place the shackle blocks. See Fig. 66.

   The shackle block is made of two blocks of wood which are shaped to conform to the top of the "bottom saddle block". The two sections of the shackle block are held together by two bolts. The shackle block permits easy removal of the keel block if that should be necessary. Loosening the bolts releases the shackle block so that it may be removed from the assembly. The shackle block should not be used to adjust the height of the block in the final setting of the keel block to the declivity line. Wedges are used for this purpose.

   As shown in Fig. 66 the top side of the shackle block is curved to accommodate the top block.

6. Place the top block. See Fig. 66.

QUESTIONS

1. **What are the names of the various blocks in the keel block assembly?**
2. **Why is the 12″ x 18″ x 30″ block made in three sections?**
3. **Why is the filler block not set at this time?**
4. **How should the wedges be placed in this assembly?**
5. **Why is the shackle block made in two pieces?**
6. **What is the purpose of the radius on the underside of the saddle block?**
7. **Explain the purpose of the gutter.**

JOB SHEET NO. 2
PLACING STRAIGHTEDGES AND TARGET BLOCKS IN GUTTER FOR RUNNING CENTER LINE OF SHIP

General Information

Placing the target blocks in the gutter is an important job and should be done with precision and accuracy. They must fit tightly and be flush with the top of the gutter wall. Keep in mind that this is the permanent target block. Study the meaning of the term and also the drawings so that the term will not be confused with the vertical target.

The straightedges at the forward and after ends of the launch slab, as shown in Fig. 68, serve two purposes. First, they act as a starting point for the surveyor; and, second, they give assurance that the ship will not be too low to accommodate the launch skids.

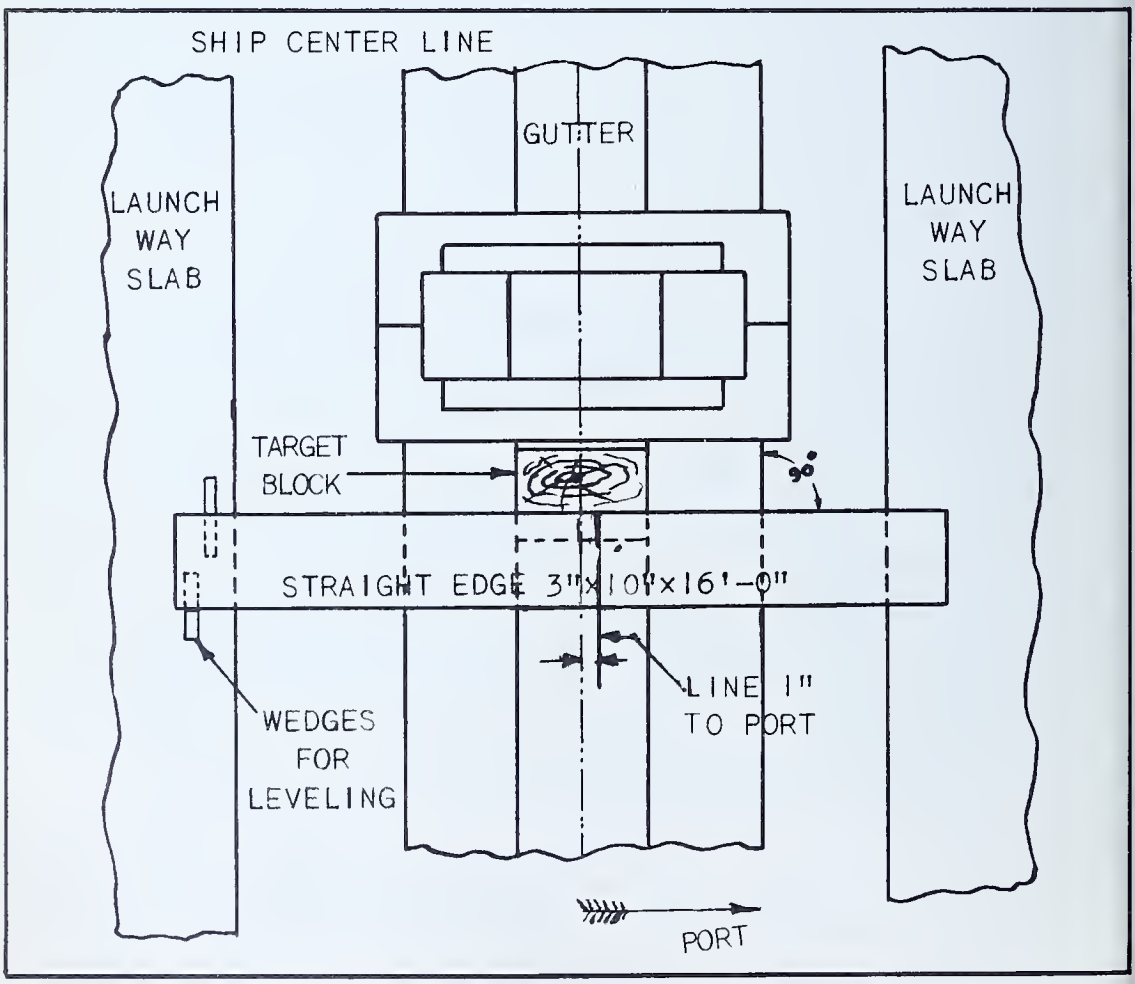


Fig. 68 — *Straightedge as a Starting Point for the Surveyor*

Tools and Materials

1. Level
2. Square
3. Maul
4. Saw
5. Rule

PROCEDURE (For setting target blocks)

1. Select pieces of 3″ x 10″ planking of sufficient length to fit between the walls of the gutter.
2. At the after side of the first keel block, measure and cut a piece of 3″ x 10″ planking exactly as long as the gutter at that particular point is wide. This piece of plank is called the target block.

   This piece of planking should be cut square and beveled under slightly, as shown in Fig. 69. The beveling aids in driving the plank tightly into the gutter, and should be not less than 1/16″ on each end.

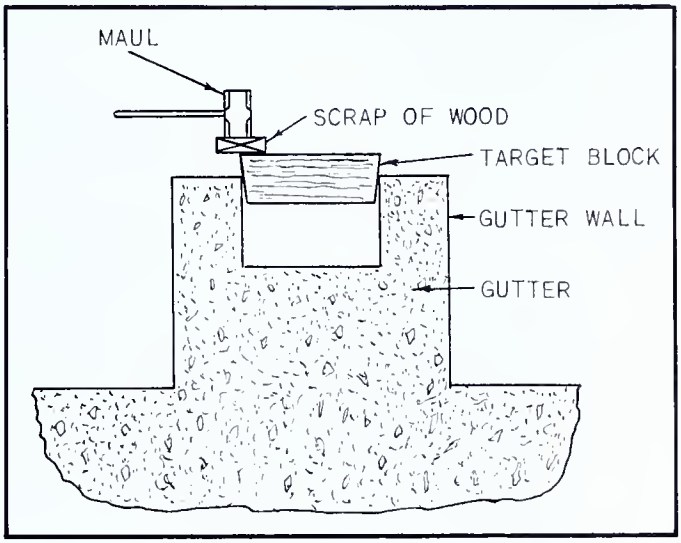


FIG. 69 — *Driving Permanent Target Block Into Gutter*

3. Drive the target block flush between the walls of the gutter at the after side of the first keel block.

   The maul is used in driving this block into place. Driving directly on the target block with the maul usually results in the splitting of the block; therefore, place a scrap piece of wood over the joint when driving the target block into position. See Fig. 69. It is important that this target block be driven flush with the gutter wall.
4. Check to see that the target block fits tightly. If it does not, remove and place another.
5. Repeat the same operation at the after side of every seventh keel block.

PROCEDURE (For setting straightedges at forward and after ends of launch slab)

1. Select two straight planks, 3″ x 10″ x 16′ 0″.

   It is important that the planks that are selected for this job are straight and free from warp.

2. Take planks to the carpentry shop for surfacing.
3. Check the proper length of planks; if they are too long, cut them to the proper length.
   The plank must be long enough to run across the gutter and rest on the launch way slabs.
4. At the forward end of the launch slab, place one of the surfaced planks across the gutter so that the ends of the plank rest on the launch way slabs. See Fig. 68.
5. Square the plank with the gutter. See Fig. 68.
6. Level the plank.
   The one end of the plank may have to be wedged up to bring the plank into level.
7. Repeat the same operation at the after end of the launch way.

QUESTIONS

1. **What is a target block?**
2. **Explain the purpose of the target block.**
3. **Why is it well to cut a slight bevel on the ends of the target block?**
4. **If a target block is cut too loosely, what is the best thing to do?**
5. **How far apart are target blocks placed?**
6. **What is the purpose of the straightedges at the forward and after ends of the launch slab?**

JOB SHEET NO. 3
SETTING THE VERTICAL TARGETS

General Information

Securing a true and permanent center line for the ship is a very important operation, since the keel of the ship must be checked and rechecked back to this line. Setting the vertical targets is only one of the operations in establishing this center line. The stage builder gives the surveyor a starting point for sighting the targets.

Tools and Materials

1. Hatchet
2. Level
3. Nails
4. Square
5. Pencil
6. 6′ rule

Other Mechanics Needed: Surveyor and carpenter.

Procedure

1. Secure the targets from the yard shop.
2. On the plank at the forward end of the launch slab (placed in Job Sheet No. 2), draw a center line to conform to the center of the gutter. (Use a rule to find the center of the gutter and a square to draw the line of the plank.)
3. Draw a line 1″ to the port side of the center line which was drawn in step No. 2.
4. On the keel block at the after end of the keel slab, nail a vertical target, the edge of which is plumb with the center of the gutter. On this wood target, clamp a small, metal target plate on which cross blocks of red and white have been painted. The metal target is clamped to the wood target so that the vertical line between the red and white squares is 1″ to the port side of the ship center line, and it is placed at a height which is convenient for back checking when setting the other targets. See Fig. 70.

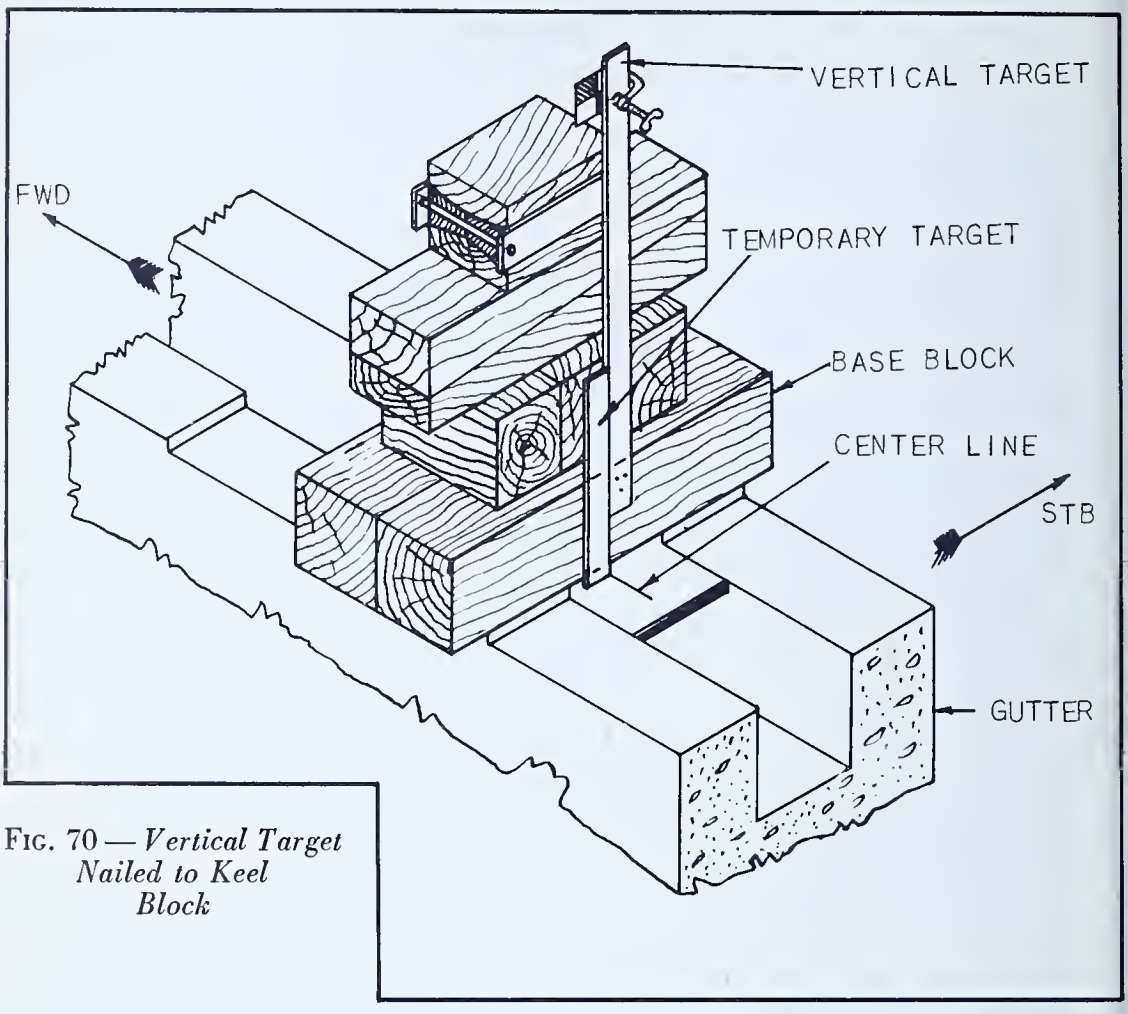


FIG. 70 — *Vertical Target Nailed to Keel Block*

A small, metal target plate is attached to the level which the surveyor uses to set the other targets. The vertical cross line on this target measures 1″ from the center line to the vertical cross line on all metal targets and permits the surveyor to sight a line the full length of the ship without inter-

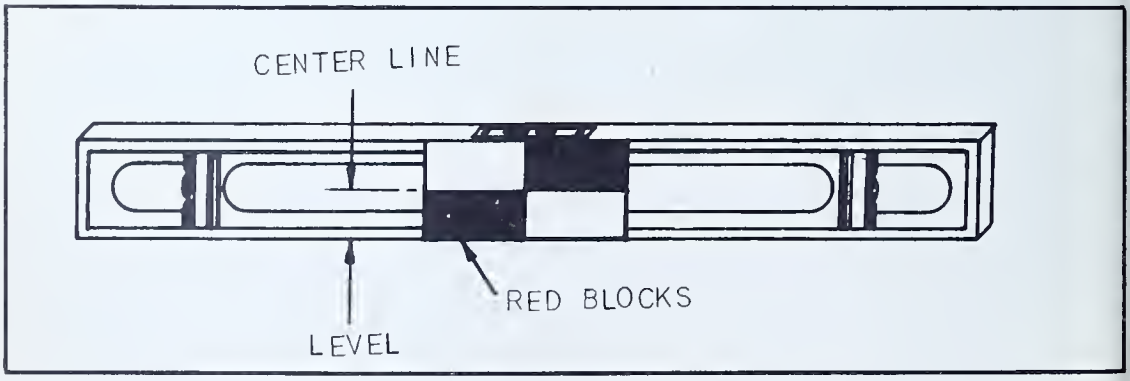


FIG. 71 — *Level Equipped with Metal Target*

ference from the wood upright or the edge of the level to which the small metal targets may be attached. See Fig. 70. Fig. 72 is an enlarged view of the metal target plates.

5. Set, plumb, and nail the remaining vertical targets.

   NOTE: The surveyor helps to locate the position of these vertical targets which are placed every seventh block. They are located over the gutter target blocks which have previously been placed.

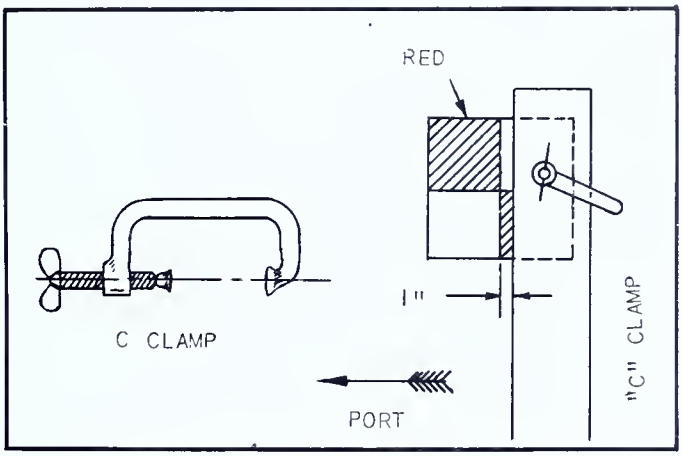


FIG. 72 — *Metal Target Clamped to Upright*

6. Establish a permanent marking on the target block in the gutter. See Fig. 70.

   NOTE: Using a straightedge, continue the line of the vertical target to the permanent target block in the gutter and draw a line. This line establishes the center line of the ship on the permanent target block. A tack is placed on this line as a permanent mark. The center line of the ship is always checked back to the center of this tack.

7. Repeat step No. 6 every seventh block. See Fig. 73.

QUESTIONS

1. **Why is it necessary to have vertical targets surfaced?**
2. **Why is a tack placed on the line which is drawn on the permanent target block in the gutter?**
3. **What is a target block, and what is its purpose?**

JOB SHEET NO. 4
SETTING KEEL BLOCKS TO THE ENGINEER'S LINE

General Information

In this job the final setting of the keel blocks takes place. The filler block is placed, and the final adjustment of the height is made. The blocks are not set exactly to the line formed by the piano wire, but each keel block is set one inch below this line. If each block were set to the wire line, any slight touching of the wire would raise the wire and throw the entire line out of straightness. Use of the gauge block permits each block to be set separately without disturbing the wire line. A chalk line is used in snapping the center line on the keel blocks. As a permanent marking, however, a saw kerf is made in the block.

Special Safety Precautions

1. When placing piano wire on the vertical targets, tie small pieces of tissue paper on the wire at various intervals so that the wire is noticeable to workers crossing the way.

Tools and Materials

1. Hatchet
2. Saw
3. Level
4. Rule
5. Chalk line
6. Chalk
7. Nails
8. Piano wire and reel

Other Mechanics Needed: Surveyor and Carpenter.

Procedure

1. Have the surveyor establish a declivity mark on each vertical target. This mark may be at any height on the target. See Fig. 73.
2. From the line set by the surveyor, establish a declivity line which is a suitable height for the particular ship to be built on the way. On a welded boat this distance is approximately 50″ from the bottom of the base block.
   A. Establish the marking on the first vertical target at the end of the way.
      (1) Measure from the base of the keel block up the vertical target block a suitable distance for the particular ship to be built. Place a pencil line and tack at that point.

(2) Cut a gauge block equal in length to the distance between the tack and the surveyor's line.

(3) Use this gauge block to mark the remaining vertical targets.

(4) Place a tack on each marking.

3. Draw piano wire over the tacks. See Fig. 73.

Fasten the wire at the after end, and attach a wire reel to the forward end. Draw wire as tightly as possible.

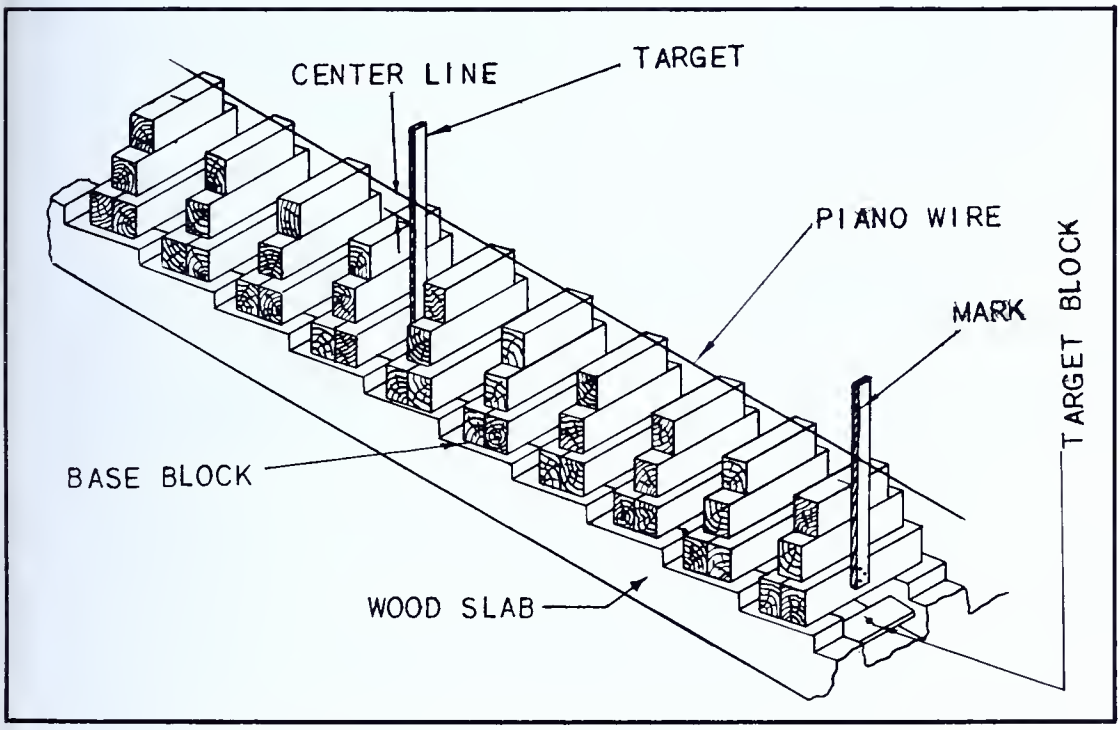


FIG. 73 — *Vertical Targets Nailed to Keel Blocks*

4. Set the keel block parallel to the line, but 1″ below it.

At this point the 1″ filler block is placed on the keel block assembly. The wedges are then used to gain the proper height of the keel block. The 1″ gauge block is used to set the top block to the declivity angle of the wire. Using the gauge block also makes it possible to set each block to the line separately. The top sections of the keel block must also be centered horizontally with the piano wire.

5. Nail each block as it is set.

6. Stretch a chalk line between vertical targets, and strike a line on the tops of the keel blocks.

7. Make a small saw kerf on each edge of the top block.

Chalk lines wear off very easily, and furthermore, the chalk line cannot be seen after the keel of the ship has been placed. Placing a small saw kerf on each side of the top block establishes permanent marks and permits the center line mark to be seen after keel is laid.

QUESTIONS

1. **Explain how a gauge block is used.**
2. **Why is a chalk line not a satisfactory center line marking for the top of the keel blocks?**
3. **What is a kerf?**
4. **What is meant by declivity angle?**
5. **Why is it important that each block be nailed as it is set in the final assembly and adjustment of the blocks?**

JOB SHEET NO. 5
LAYING OUT GENERAL ARRANGEMENT OF SHIP ON SHIPWAY AND ESTABLISHING STARTING POINT OF KEEL

General Information

The stage builder does not lay out the general arrangement of the ship on the ways. This is done by the foreman of the department; however, the stage builder does assist in holding the tape and in marking the spacings on the gutter wall. In the process of laying out the general arrangement of the ship, the starting point of the keel is determined and marked on the gutter wall.

Tools and Materials

1. Hatchet
2. Saw
3. Level
4. Tape
5. Declivity board
6. Paint

Other Mechanics Needed: Carpenter and the foreman of the Stage Building Department.

Procedure

1. Take all measurements from the general arrangement of the ship and the bulkhead locations marked on the gutter walls.
   A. Hold tape for layout man.
   B. Mark the bulkhead spacings on the gutter wall.
2. Have the foreman determine or check the starting point of the keel on the gutter wall. (This point is usually at or near the center of the ship.)
   This is an extremely important operation. If the keel is not started in the proper place, the ship may lie too far forward or too far aft on the shipway. The ship must be placed to suit the launching and also the staging so as to permit the turning of the rudder. It may be performed by the leader; *however, it must always be checked by the Foreman.*
3. Nail two 1″ x 3″ boards between the keel blocks which are found on each side of the marking on the gutter. See Fig. 74.
4. Transfer the mark on the gutter wall to the 1″ x 3″ boards.
   Plumb from the mark on the gutter wall to the 1″ x 3″ boards which have been placed between the keel blocks. Mark this point. A declivity board must be used in this plumbing operation. Fig. 74 shows this operation clearly.

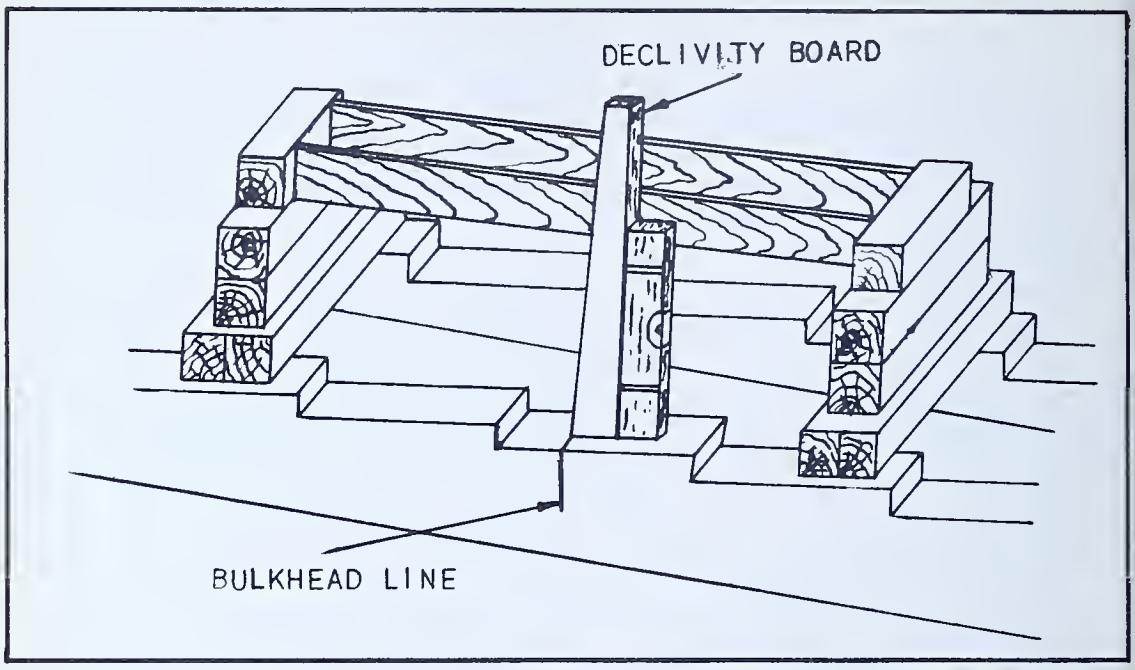


FIG. 74 — *Establishing the Starting Point of the Keel*

QUESTIONS

1. **Whom does the stage builder assist in laying out the general arrangement of the ship?**
2. **Why is the establishing of the starting point of the keel so important an operation?**
3. **How is the starting point of the keel established?**
4. **Approximately where does the starting point of the keel fall?**

JOB SHEET NO. 6
SETTING BLOCKS FOR LONGITUDINAL BULKHEADS

General Information

The bottom of the ship from the after end of number one tank to the forward end of number nine tank is relatively flat except for the upward slant to the bottom from the keel outward. This slant is called the dead rise of the ship.

The operations of setting the longitudinal blocks and the vertical targets are very similar to setting the keel blocks and targets; however, the longitudinal blocks need not be placed so accurately as the keel blocks.

Special Safety Precaution

Exercise care in handling the heavy blocks.

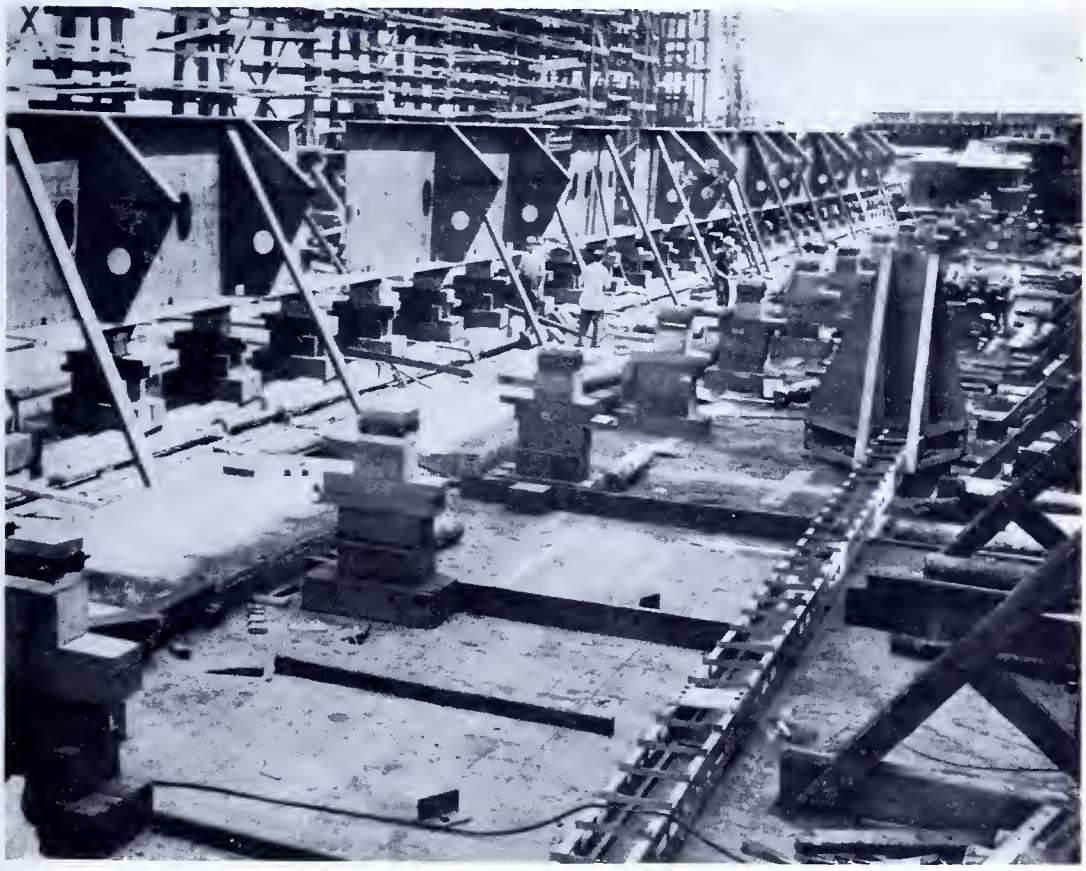


Fig. 75 — *Setting the Keel*

Tools and Materials

1. Dead rise board
2. Level
3. Chalk line
4. Hatchet
5. Nails
6. Tacks
7. Tape

OTHER MECHANICS NEEDED: None.

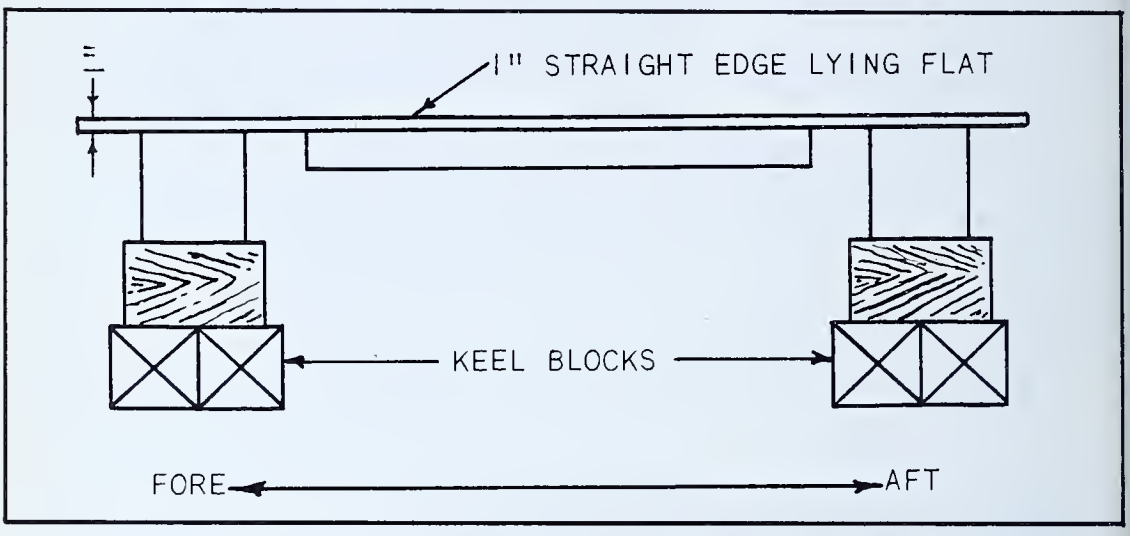


FIG. 76 — *Straightedge for Setting Dead Rise Board*

PROCEDURE

1. Measure out from the center line of the keel the distance which the longitudinal bulkhead is located from the center line of the keel.
   A. A tape is used to take this measurement.
   B. This measurement is to the center of the longitudinal bulkhead blocks.
   C. This measurement varies with the size of the ship.
   Set or place the longitudinal blocks every 16 feet from the after end of number one tank to the forward end of number nine tank.
2. On every other longitudinal block, erect a vertical target. See Fig. 70.
   Follow the same procedure as in setting vertical targets on keel blocks.
3. Place a 1" thick straightedge on the keel blocks opposite the first longitudinal block. See Fig. 76.
   This straightedge board is laid flat and is prevented from sagging by nailing another straightedge underneath in an edgewise manner. See Fig. 76.
4. Place the large end of a dead rise board on top and at right angles to the straightedge. Level the dead rise board, and mark the height on the vertical target. See Fig. 77.
   Pencil marks must be made on the bottom of the dead rise board when marking vertical target.

5. Repeat step 4 on each vertical target.
6. Place tacks in markings on vertical targets.
7. Fasten chalk line from tack to tack.
8. Set the longitudinal bulkhead blocks to the chalk line.
   Use the 1″ gauge block in setting the blocks to the line.

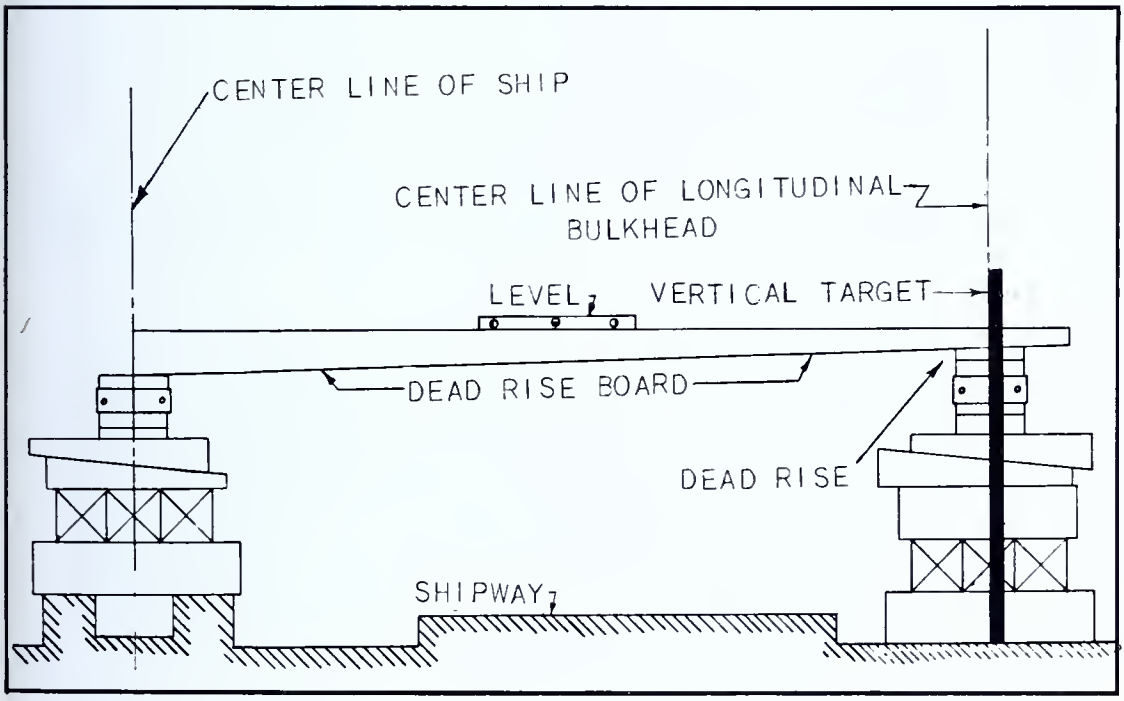


FIG. 77 — *Setting the Dead Rise Blocks for the Longitudinal Bulkhead*

QUESTIONS

1. **How will the longitudinal bulkhead blocks be set in relation to the keel blocks?**
2. **How do the number of longitudinal blocks compare with the number of keel blocks? Explain.**
3. **What is a standard distance for placing longitudinal bulkhead blocks? Explain.**
4. **Explain the procedure for erecting vertical targets.**
5. **Why is the gauge block used in setting blocks to the line?**

JOB SHEET NO. 7
LAYING, CENTERING, AND SHORING THE KEEL

General Information

The ship erector sets the keel of the ship to marks laid out by the stage builder. The stage builder aligns the keel with the kerf markings on the keel blocks and then shores the keel in this position. Since the stage builder is the one responsible for keeping the keel in alignment, he is interested in the initial setting of the keel while the crane is still attached. In this operation, the kerf marks on the top block are used for centering the keel; however, the final checking is always made to the center of the tack found in the permanent target block in the gutter.

Special Safety Precautions

1. Handle the maul carefully. Be certain there is no one who might be injured working nearby.
2. Refrain from looking directly at the welding flares.

Tools and Materials

1. Plumb bob
2. Chalk line
3. Maul
4. Saw
5. Wedges

Other Mechanics Needed: Welder, Erectors.

Procedure

1. Assist erectors in placing the first section of keel.

   The stage builder assists the erector in placing the section of keel on the keel blocks at the starting point of the keel. The stage builder is interested in getting the initial setting of the keel as closely as possible on the center line. He is interested in the proper setting of the keel so that it may be centered more easily.

2. Shore the keel section laid in step No. 1.

   This is a temporary shore, the purpose of which is to hold the keel erect until permanent alignment and shoring is completed. Temporary shores are shown in Fig. 78.

3. Work each succeeding keel section in the same manner.
4. Secure clips.

5. Assist welder in placing clips.
   A. Clips are welded on the center line and on the underside of the keel.
   B. Two clips are placed on each section of keel, one clip at each end.
6. Place spur shores on each side of each clip.
   Spur shores must be grounded on the concrete and not on gravel. See Fig. 78 at "b".

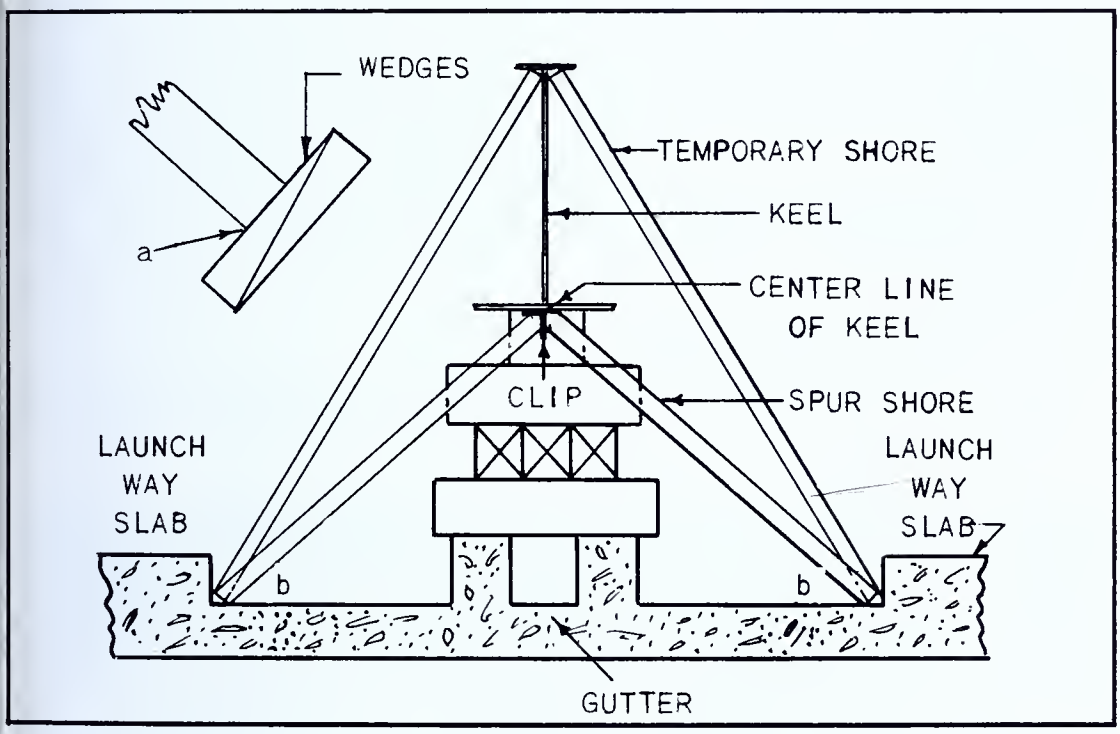


FIG. 78 — *Keel Shored to Place*

7. Run a chalk line from target block to target block under the keel blocks.
8. Line the keel.
   Plumb from the center line marked on the underside of the flat keel at a point where the transverse bulkhead will be placed.
9. Drive wedges back of the spur shores to place the keel on center and hold it in position. See Fig. 78 at "a".
   After driving the keel into its exact location, wedge shores securely.

QUESTIONS

1. **What is the purpose of the spur shore?**
2. **Why is the keel not shored permanently as each section is set?**
3. **For what purpose is a "clip" used in this job?**
4. **Explain how the keel is finally centered.**
5. **Who keeps the keel in alignment?**
6. **Explain how the keel centering is checked.**

JOB SHEET NO. 8
SETTING SHORING FOR BOTTOM SHELL

General Information

The shores for the bottom shell cannot be placed before the shell is drawn into position. Four rows of shores are placed under the bottom shell. Templates must be cut for the four different sizes. The shores are cut before the placing of the shell begins; however, the placing of these shores is done after the shell has been moved into position and while it is still supported by the crane. The shell section should also be secured to the keel before the actual shoring operation begins.

Special Safety Precaution

Shoring should never be begun before the section has been fastened to the keel.

Fig. 79 — *Cutting Timbers for Shores*

Tools and Materials

1. Maul
2. Wedges
3. Cross Cut Saw
4. Measuring stick
5. Level
6. Declivity board
7. Template board

OTHER MECHANICS NEEDED: Erectors.

PROCEDURE

1. Make a pattern or template for cutting the shores. See Fig. 80.
   A. Procedure for cutting template.
      (1) Run a straightedge from a keel block to one of the longitudinal blocks. See Fig. 80.
      (2) Lay the 3" x 10" x 16" shole block directly beneath the straightedge at the point where that particular row of shores will be run. See Fig. 80.

This shole block acts as a good foundation for this shore, and it also permits the wedges to be driven more easily in placing the

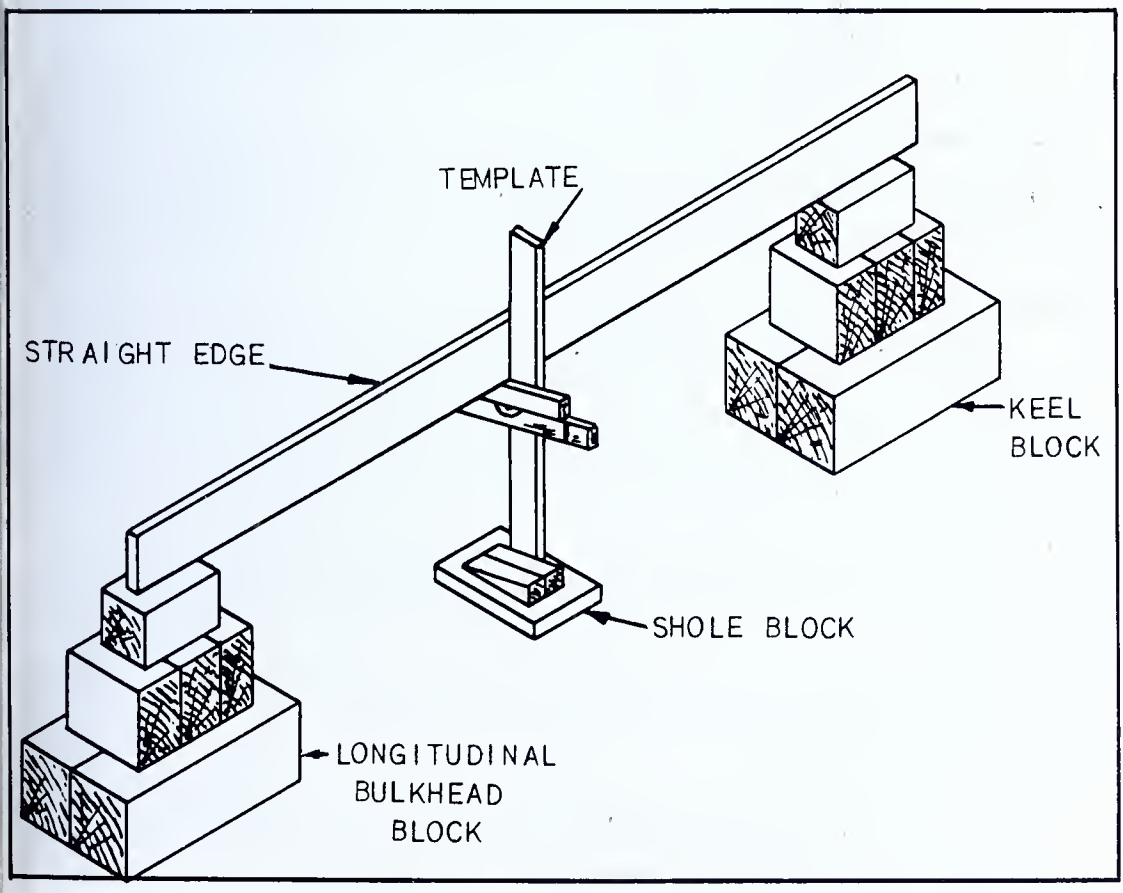


FIG. 80 — *Marking Template for Bottom Shores*

shores. Still a more important function is to permit easy removal of the shores in preparation for the launching.

(3) Place a wedge on top of the shole block previously placed in step 2.

(4) Select a piece of template board.

(5) Place the template board edgewise against the straightedge board and also against the wedges as shown in Fig. 80.

The top edge should rest lightly against the straightedge; the bottom, however, should be inclined 2″ away from the perpendicular. These shores for the bottom shell must be inclined 2″ toward the fore end of the way in order to support the ship in its inclined position properly.

(6) Hold the template board in this position, and scribe a pencil line across the top of the wedge. See Fig. 80.

(7) Scribe the top line. See Fig. 80.

Place a declivity board and level against the bottom of the straightedge level, and draw the line along the top edge of the declivity board.

(8) Mark template 1″ shorter.

Mark the template board 1″ shorter so that the body of the wedge, rather than only the point, rests under the shore.

(9) Saw out the template.

B. A separate template must be cut for each row of shores.

2. Mark shores from the template and cut.

These shores are cut from round piling which is 8 to 10 inches in diameter.

3. Shore the first section of bottom.

When the erectors have placed the first section of bottom so that it is attached to the keel and rests on the longitudinal blocks, the stage builder shores that section before the crane is removed. These shores must be placed under frames or longitudinal stiffeners. Placing them otherwise would cause a bulge in the boat bottom.

4. When sufficiently shored, have the erector remove the crane.

Such a section is not sufficiently shored until at least eight shores have been placed.

5. Repeat the same operations until all prefabricated sections have been laid.

6. Shore the single plates.

From the engine-room forward bulkhead to the after end of the ship, the plates are erected as single plates. Here each shore is cut separately because of the rapid curvature of these plates. These plates should also be securely attached to adjoining plates before the shoring begins.

QUESTIONS

1. What is a template?
2. Explain how the templates for shores are marked and cut.
3. When is the actual shoring operation begun?
4. In shoring the bottom shell, where should shores be placed? Why?
5. What is round piling?
6. When is it safe to remove the crane from the section being shored?
7. Why must the shores for some sections be cut separately?

JOB SHEET NO. 9
SHORING AND FASTENING
THE CENTER MIDSHIP TRANSVERSE BULKHEADS

General Information

The center midship transverse bulkhead is the most important bulkhead as far as centering, shoring, and plumbing are concerned. This bulkhead is shored and cabled on the after side, whereas the remaining bulkheads are only cabled on the forward side.

The center midship transverse bulkhead is the only one which is plumbed for declivity since all others are plumbed automatically when the deck girders are placed. All transverse bulkheads must be plumbed transversely.

Special Safety Precautions

Fastening the cables to the top of the bulkhead before the bulkhead is erected eliminates the danger of hazardous climbing.

Tools and Materials

1. Cables
2. Cable clamps
3. Wrench
4. Ratchet turnbuckle

Other Mechanics Needed:

Erector, Regulator.

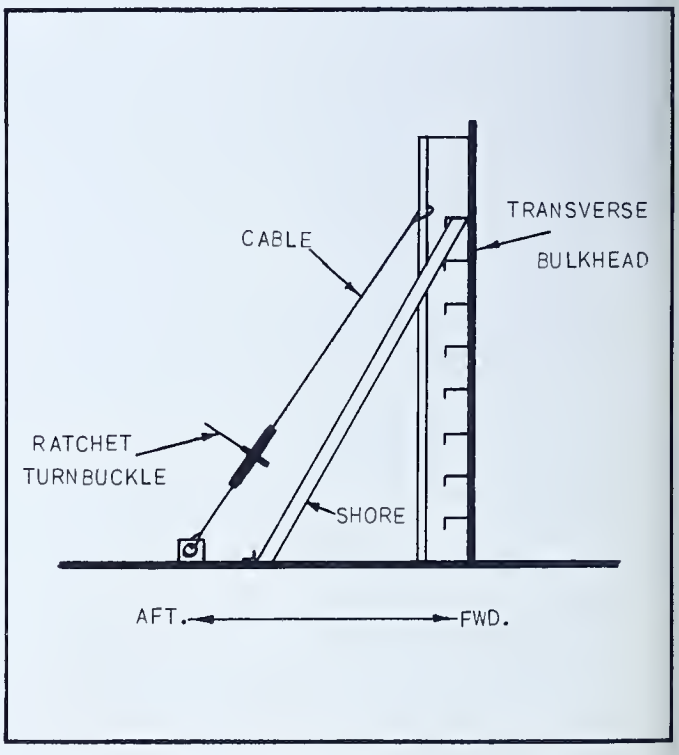


Fig. 81 — *Shoring Center Midship Transverse Bulkhead*

Procedure

1. Have the erectors place into position the after bulkhead of the midship pump room.

This center bulkhead of the midship pump room is the first transverse bulkhead which is set and shored. This bulkhead is plumbed and fastened securely with shores and cables, and all succeeding bulkheads are set automatically to the proper declivity when the deck girders are placed into position. See Fig. 81.

FIG. 82 — *Showing Two Rough Timbers (Shores) Set in Place*

2. Place shores on the after side of the bulkhead.

These shores are long, round piling which reach from near the top of the bulkhead to the bottom shell. See Fig. 82.

3. Place cables at the after side of the bulkhead.

One cable is placed on the top of the outside vertical stiffener on both outboard sides of the bulkhead. The cables extend from the top of the bulkhead to a clip welded to the bottom shell, or to one of the lightening holes in a longitudinal stiffener. The cable is usually attached to the top of the bulkhead before erection. This eliminates climbing to the top of the bulkhead after it has been erected.

4. Tighten the cables so that the bulkhead is held tightly against the wooden shores.

The cable is tightened by drawing the ratchet turnbuckle.

QUESTIONS

1. Explain how the center transverse bulkhead is shored and fastened.
2. The cables supporting the bulkheads are placed on which side of the bulkhead? Why?
3. How many cables are placed on each bulkhead? Where and when are they placed?
4. How are the cables tightened?
5. What other mechanics work with the stage builders on this job?
6. State what transverse bulkheads are plumbed with a plumb bob and line.

JOB SHEET NO. 10
PLUMBING THE CENTER MIDSHIP TRANSVERSE BULKHEAD

General Information

The stage builders do all plumbing, checking, and shoring of bulkheads. Stage builders also do the general aligning of a ship. It is important, therefore, to review again the plumbing operation and the application of declivity in plumbing in a fore-and-aft direction.

Special Safety Precautions

In this job the stage builder must climb to the top of the bulkhead to suspend the plumb bob in the plumbing operation. Climbing is especially hazardous where there is no supporting staging; therefore, the stage builder who does the climbing should wear good shoes and ascend the bulkhead slowly and cautiously.

Tools and Materials

1. Plumb bob
2. Rule
3. Chalk
4. Tape

Procedure

1. Ascend the bulkhead with plumb bob. See Fig. 83.

   Climbing bulkheads is hazardous; therefore, climb carefully.

2. Drop the plumb bob on the after side of the vertical stiffener.

   The plumb bob is dropped along a vertical stiffener because this stiffener has a definite straight line running from the top of the bulkhead to the bottom shell.

3. Determine the declivity distance. Distance "A", Fig. 84. Multiply

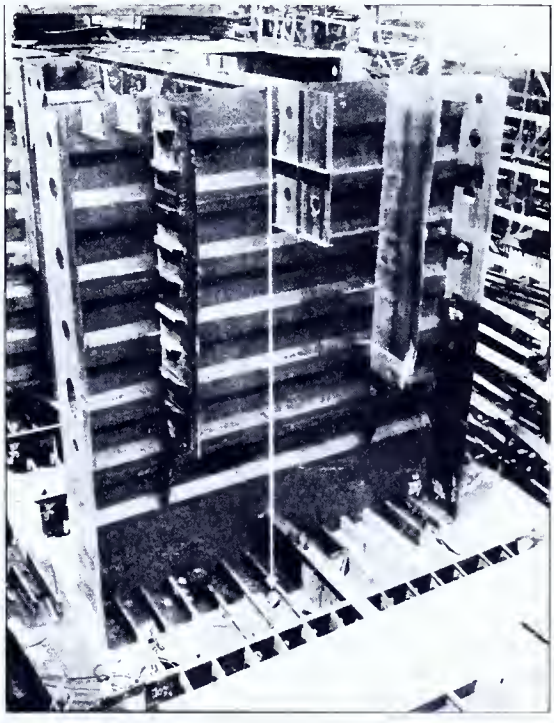


Fig. 83 — *Plumbing the Center Section of Transverse Bulkhead*

the height of the bulkhead in feet by the declivity per foot. This will give the dimension "A", or the distance which the top of the bulkhead is thrown aft.

4. Measure the distance of declivity from the after side of the stiffener.

5. Mark this measurement on the bottom shell.

6. Adjust the bulkhead so that the plumb bob falls ¼" forward of the mark.

   The bulkhead is driven into plumb by adjusting the shores and cables. It is thrown ¼" forward to compensate for a slight shifting in the after direction when the other bulkheads are placed.

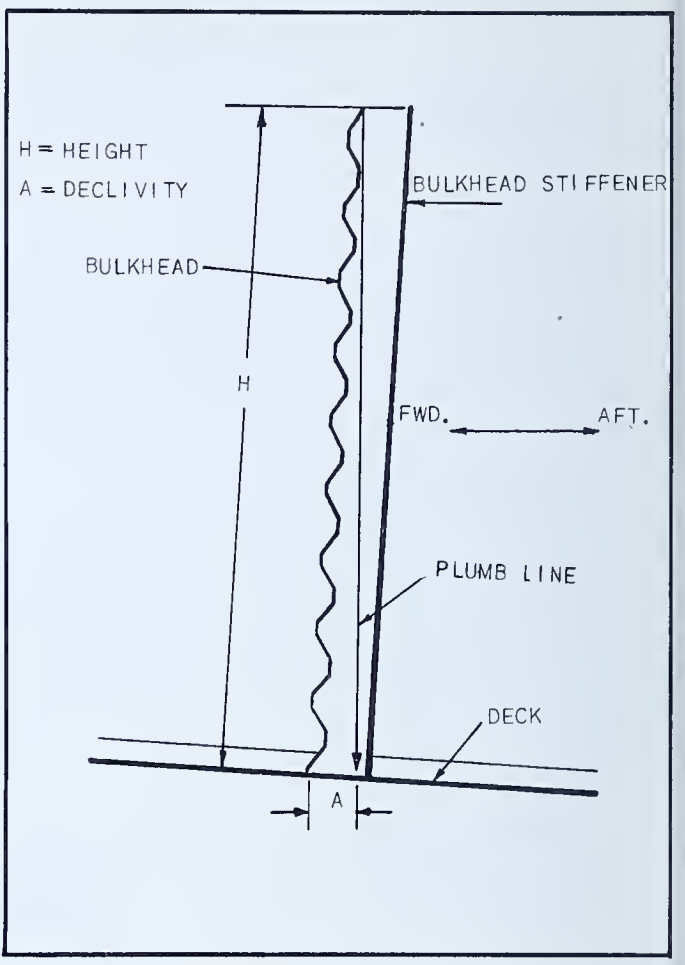


FIG. 84 — *Plumbing a Transverse Bulkhead*

7. Place remaining transverse bulkheads.

   A. The remaining transverse bulkheads are worked both ways from the center midship transverse bulkhead.

   B. These bulkheads need not be plumbed for declivity since the deck girders automatically bring them to the proper declivity.

   C. These bulkheads are not shored; the center midship transverse bulkhead is the only one which is shored.

   D. The bulkheads are held in place with cables which are attached to the forward side.

      These bulkheads are fastened with cables on the forward side since the bulkhead is leaning toward the after end of the way.

QUESTIONS

1. How is the declivity on a transverse bulkhead determined?
2. Do the transverse bulkheads hang fore or aft in relation to the bottom shell?
3. How could the bulkhead be plumbed on the forward side?
4. On what part of the transverse bulkhead is the plumbing best done?

JOB SHEET NO. 11
PLUMBING AND SHORING WING BULKHEADS

General Information

The wing bulkhead usually rests on a section of the bottom. The weight of the bulkhead, however, is too great for the bottom shell, so it must be held by a wooden piling shore until plumbed and tacked. The wing bulkhead is swung into position with the crane, bolted, and tacked to the longitudinal transverse bulkhead; then it is shored in that position. The shore should be placed in a relatively vertical position.

Tools and Materials

1. Saw
2. Measuring stick
3. Wedges
4. Maul
5. Cable

Procedure

1. Have the erectors set the bulkhead into place.

2. Select a suitable, round piling shore.

3. Cut the end of the shore to fit the contour of the transverse stiffener.

4. Cut the shore to proper length.

   When cutting the shore to length, keep in mind that a shole block and wedge must be placed under the shore.

5. Place the shore. See Fig. 85.

   The purpose of this shore is to hold the weight of the bulkhead until it is properly tacked. Place the shore on the after side of the bulkhead and as close to the shell line as possible. Drive the shore securely.

6. Plumb the wing bulkhead.

   Use the same plumbing procedure as was used in plumbing the center transverse bulkhead. When the wing bulkhead is too badly out of line, a cable must be attached to pull the bulkhead into plumb.

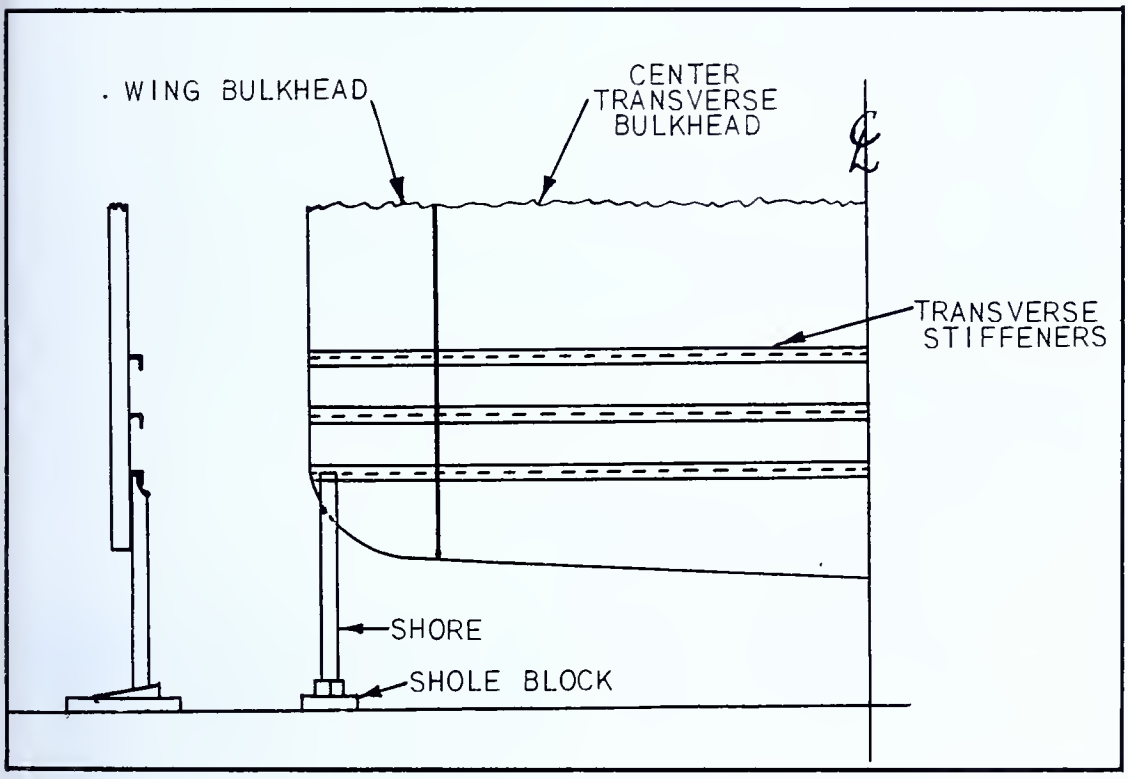


FIG. 85 — *Wing Bulkhead Shored in Place*

QUESTIONS

1. **In step 5, why is the shore placed as close to the shell line as possible?**
2. **Why is it necessary to cut the end of the shore to fit into the contour of the transverse stiffener?**
3. **Explain the operation of plumbing a bulkhead.**

JOB SHEET NO. 12
SHORING THE SIDE SHELL

General Information

One point which needs to be emphasized is that clips used in supporting the side shell shores must be welded on the underside. If this is not done, the clip will be pulled off when the shores are driven into place. Another important item is that these shores must be placed above the bilge of the ship. The weight of the side shell is not supported properly if the shore is placed on the curvature of the bilge.

Special Safety Precaution

Avoid looking at welding flares without proper eye protection.

Tools and Materials

1. Block and tackle
2. Saw
3. Measuring sticks
4. Clips
5. Wedges

Other Mechanics Needed:

Welder, Erectors.

Procedure

1. Select suitable, round piling shores.
2. Have the erector set the side shell section.

   One side shell section is usually as long as one tank.
3. Locate the position of the shore clips.

   A suitable shore is selected and placed into position. The shore need not be any particular height; it must, however, reach above the bilge of the ship. Two clips and two shores are necessary to support one section of shell.

Fig. 86 — *Shores Supporting Shell*

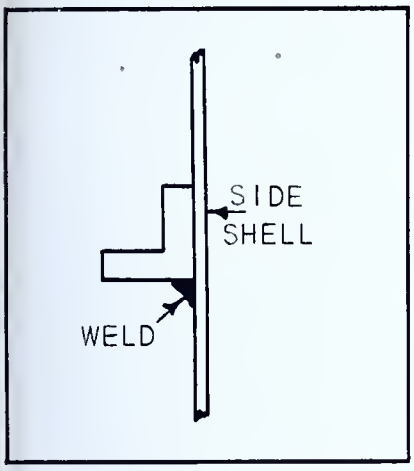


FIG. 87 — *Showing Weld on Under Side of Clip*

4. Attach the clips in their exact position.

   The stage builder holds the clip in its exact location while the welder tacks it. The shore is then removed, and the welder properly welds the clip. Caution the welder to weld on the underside of the clip. It will pull off if this is not done. See Fig. 87.

5. Inspect clips to see that they are welded on the underside.

6. Cut the shore to the proper length.

7. Place the shore. See Fig. 86.

   Place the shore into position as shown in Fig. 88 and drive wedges until the shore is secure.

8. Shore all the succeeding vertical side shells.

9. Shore the forward and after ends.

On the forward and after ends of the ship, individual plates are erected rather than large prefabricated sections. Each individual plate must be shored into position.

QUESTIONS

1. **How many shores are placed in each section?**
2. **What is the most important item concerning the placing and fastening of the clip?**
3. **Why must all side shell shores be the same length?**
4. **Explain why the shole block is necessary in the shore assembly.**

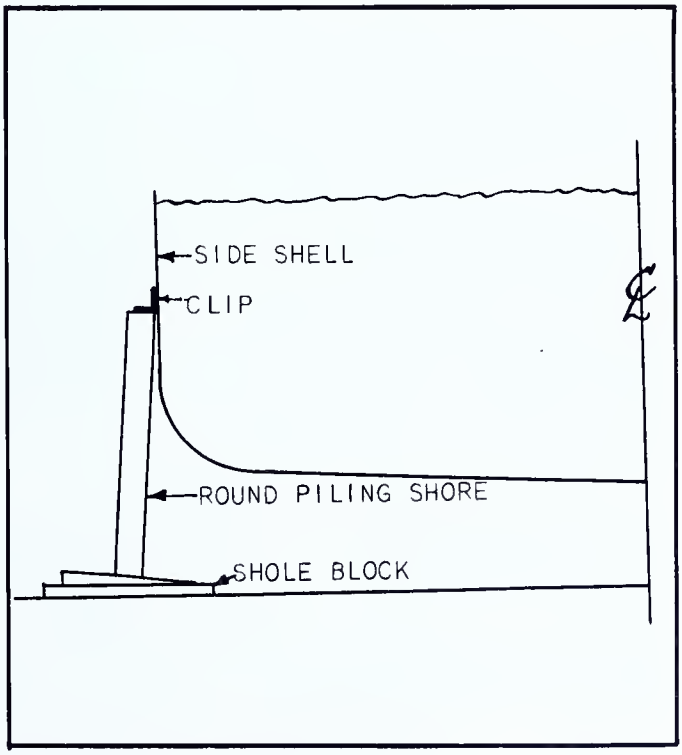


FIG. 88 — *Shoring Side Shell*

JOB SHEET NO. 13
SETTING BILGE CRIBBING

A bilge cribbing is built at the outboard sides of a ship for additional support during the working time the ship is on the way.

As shores and keel blocks are removed and replaced for various work operations, the bilge cribbings are one of the main supports of the ship.

On launching day the cribbings are the last support to be removed and then are removed only a few minutes before the actual launching takes place.

The bilge cribbings are built into place as soon as the steel is erected at the location of the bilge cribbing. See Fig. 89.

The locations of bilge cribbings on tankers are usually the forward cofferdam, the midship pump room, and the after cofferdam.

The location of bilge cribbing on a cargo or freighter ship is in similar positions under bulkheads and frames.

FIG. 89 — *Showing Bilge Cribbing in Place*

To place cribbing, plumb down from the bulkheads or frames so that the cribbings are directly under the bulkheads or frames.

PROCEDURE

1. Place 12″ x 12″ x 48″ base logs athwartship under bulkhead or frame.
2. Place 3″ x 10″ plank of desired length fore and aft at both inboard and outboard ends of the base logs.
3. Duplicate steps 1 and 2 until the cribbings are of proper height.
4. Put long wedges in an athwartship position directly over the base logs. These wedges are for the purpose of making minor adjustments in height.
5. Next place patented shackle blocks into position on both inboard and outboard ends of the wedges. These blocks are adjustable. (Fig. 90). They are

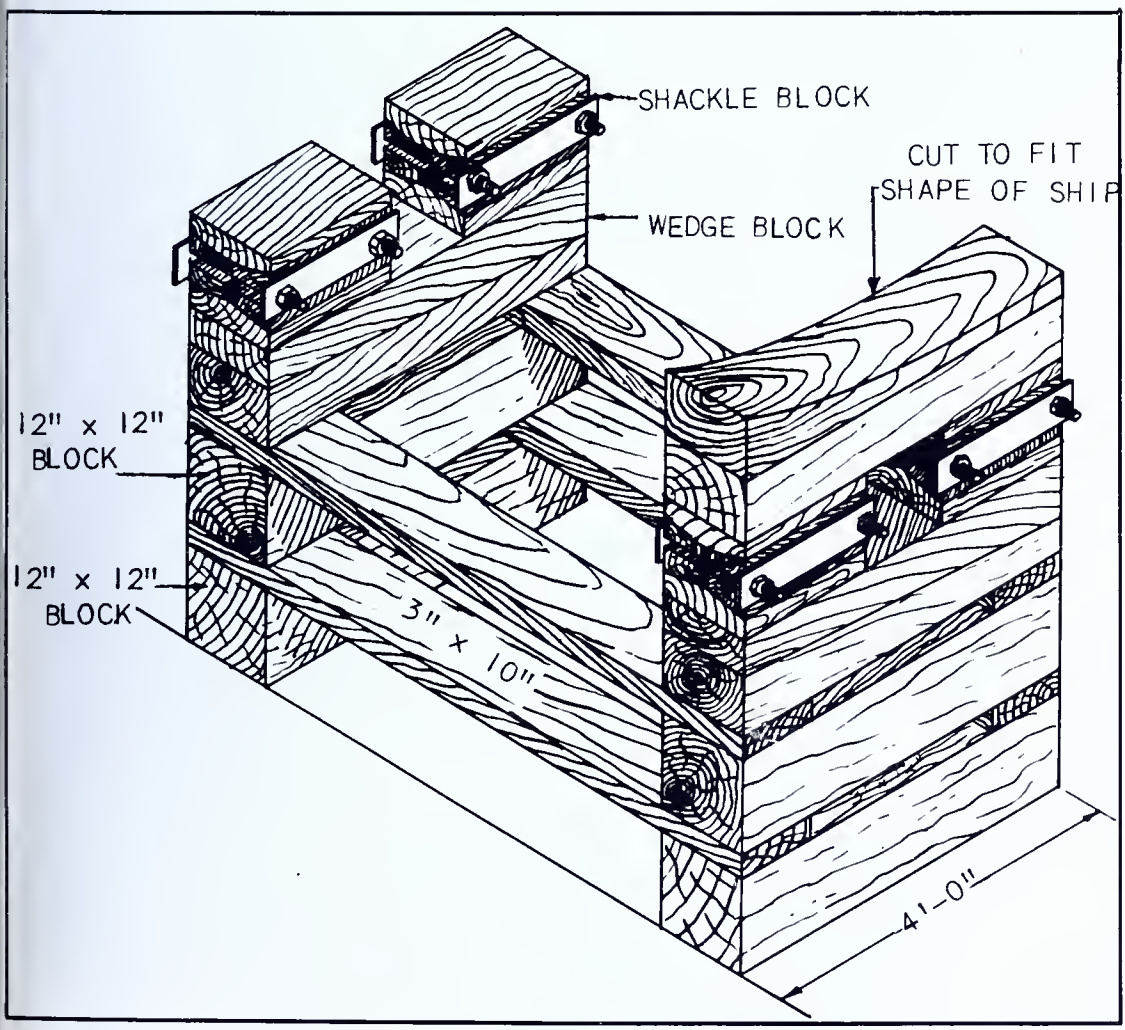


FIG. 90 — *Details of Bilge Cribbing*

built of four different wood parts with iron plates on each side and 7/8″ bolts going through the plates at each end.

When the nuts on the bolts are loosened, the center two blocks of wood spread and allow the wedge blocks to slide and lower.

6. Place a strong block between 8″ to 12″ in height, 12″ wide, and 48″ long upon the shackle block in an athwartship position. Blocks of this type are put upon each set of shackle blocks. The height or thickness of the block is estimated so that 4″ to 5″ are allowed between the shell and the top blocks.

7. Lift a template from the height of the top timber to the shape of the ship's bottom. This template is lifted in much the same manner as in lifting a boat chock shown in Figs. 237 and 238, Part V.

8. Select a piece of strong timber, lay the template on the timber, and mark the shape to be cut. Band saw to the line. Install the timber in the correct position, placing tar felt and paint between the wood and the steel shell.

9. Drive in the wedges tight under the shackle blocks.

Tighten the bolts of the shackles with a wrench until the two center blocks, pulled together, complete the cribbing.

QUESTIONS

1. **What is the purpose of bilge cribbings?**
2. **Why must the bilge cribbing be placed under bulkheads or frames?**
3. **Why should the bilge cribbing be placed as far outboard as possible?**
4. **How is the height of the bilge cribbing determined?**
5. **What is the purpose of the wedges?**
6. **What are shackle blocks?**
7. **How are the templates lifted?**
8. **Explain how the cribbings are made tight between the shipway and the ship.**

JOB SHEET NO. 14
STAGING THE CENTER TANKS

General Information

Primarily, the staging for the center tanks is erected to assemble the side walls of the tank. After the walls have been erected, the staging must be rebuilt at many places to accommodate the incidentals such as operating rods for valves, ladders, pipes, etc., which must be placed. If the stage builder knows approximately where some of these incidentals are located in the tank, the initial staging can often be constructed around such points.

All flights of staging, except the top flight, are narrow stagings two planks wide. The top staging covers the entire tank, thus necessitating the use of the spawls.

Uprights are not needed for the fore side of the tank since the planks are laid directly on the transverse stiffeners. Two additional uprights are needed in staging a tank having corrugated bulkheads.

Ladder bolts are placed on the upright located in the center of the longitudinal bulkhead close to the tank opening. Fig. 91 shows how these bolts are placed.

Special Safety Precautions

Here again, climbing about on the bulkheads and uprights is very dangerous. Wear good shoes, and do not climb into dangerous or awkward positions.

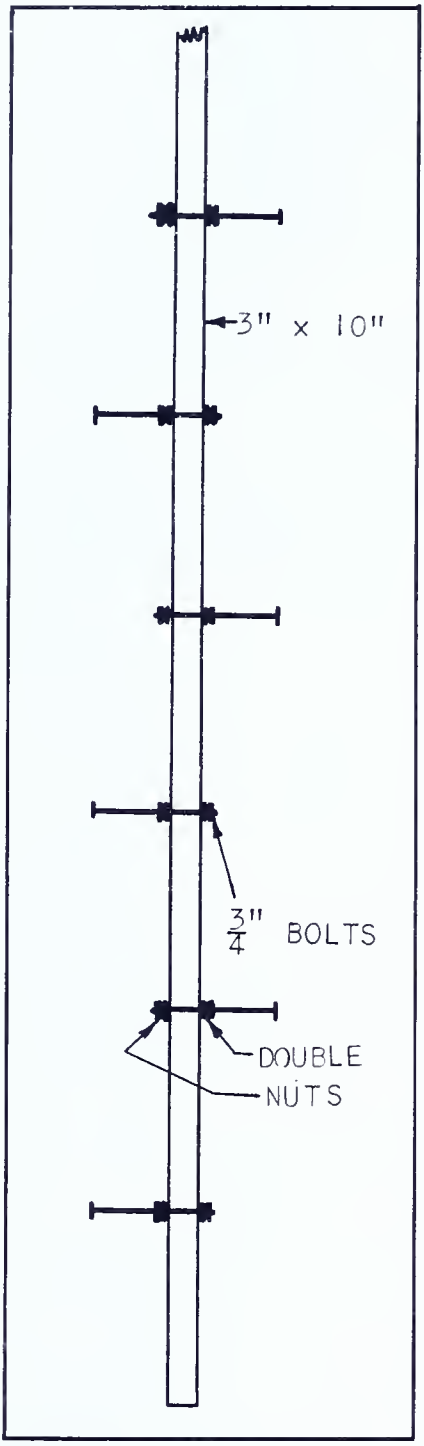


Fig. 91 — *Ladder Bolts in Upright*

Tools and Materials

1. Tape
2. Saw
3. Wrench
4. Brace and bit
5. Rope
6. Chain
7. Bolts
8. Hangers
9. Staging brackets
10. Clips
11. Hook bolts

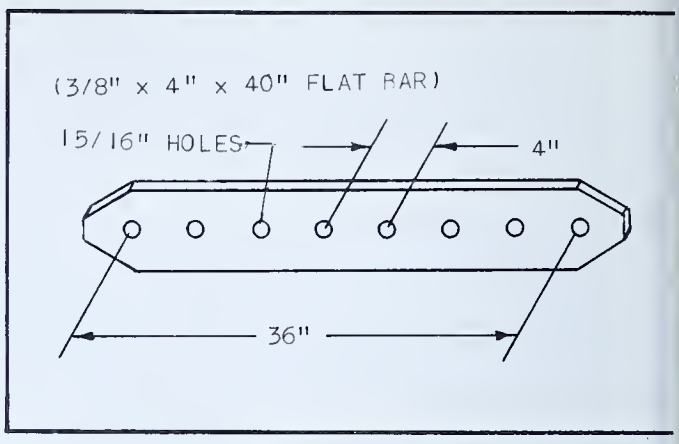


FIG. 92 — *Staging Bracket*

OTHER MECHANIC NEEDED: Welder.

PROCEDURE

1. Determine the height of the bulkhead at the center of the tank.
   This measurement is needed to determine the over-all height of the uprights

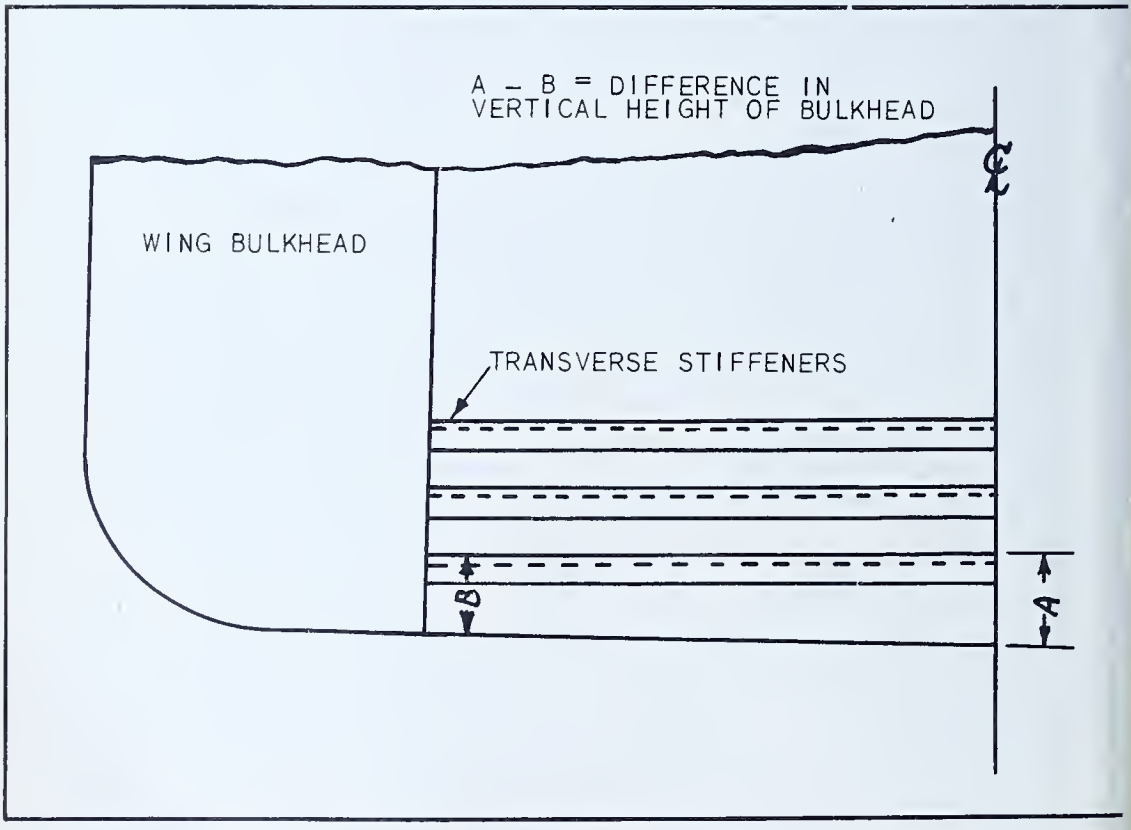


FIG. 93 — *Determining the Difference in Vertical Height of a Transverse Bulkhead*

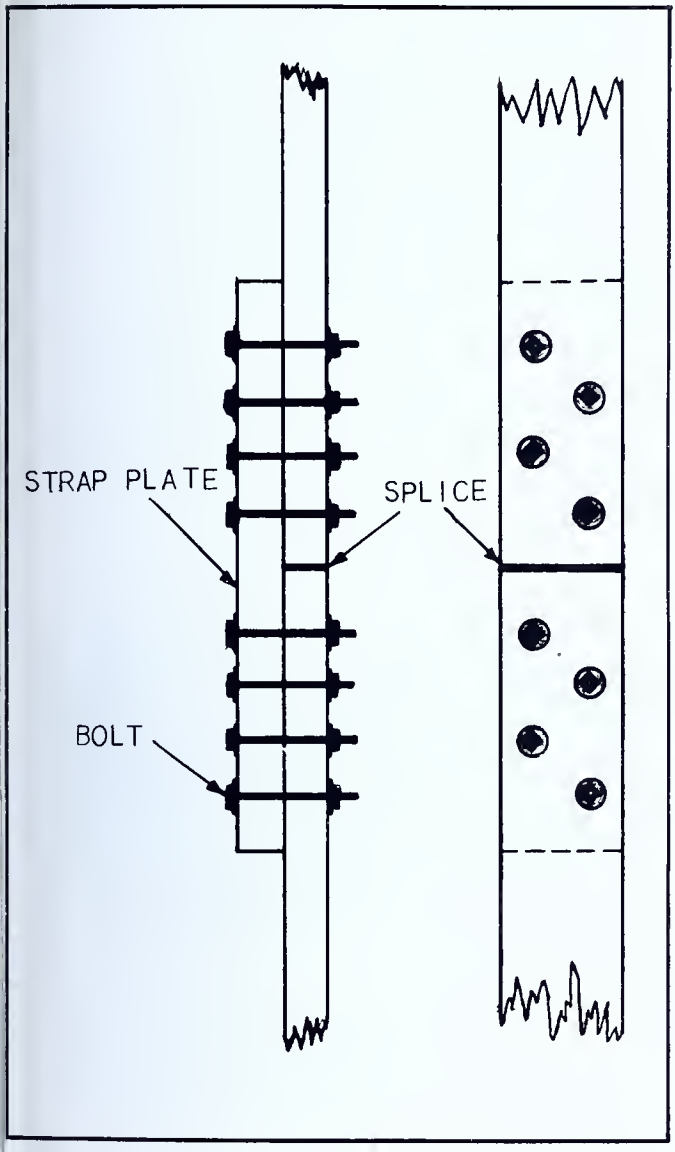


FIG. 94 — *Splicing Uprights*

2. Determine the difference in the height of the bulkhead at the center of the ship and at a point near the longitudinal bulkhead. See Fig. 93.

   This difference in height is needed because of the dead rise of the bottom shell. This dead rise necessitates making the uprights which run fore and aft shorter than the uprights which stand in the center of the tank. The difference in height can easily be found by measuring from the first transverse stiffener on the bulkhead to the bottom shell at the points shown on Fig. 93.

3. Select 3″ x 10″ material for making the uprights.

   (This timber must be straight-grained and free from knots).

4. Construct the uprights. (The total height should be 3 ft. shorter than the height of the tank).

A. Select two suitable lengths of planking.

B. Butt the two lengths of plank together, and bolt a strap plate on one side. See Fig. 94.

C. Determine the height of the figure 4 brackets for a straight bulkhead.

   (1) The height of the first bracket is the same height from the bottom shell as the third transverse stiffener.

   (2) The height of all remaining brackets is the same height or in line with every other transverse stiffener. See Fig. 95.

D. Determine the height of the figure 4 brackets for a corrugated bulkhead.

   (1) The top flight of staging may not be more than 6 feet in height.

(2) The remaining flights are spaced evenly, but they should not be more than 6 feet in height.

E. Lay out on the uprights the heights of the various flights of staging.

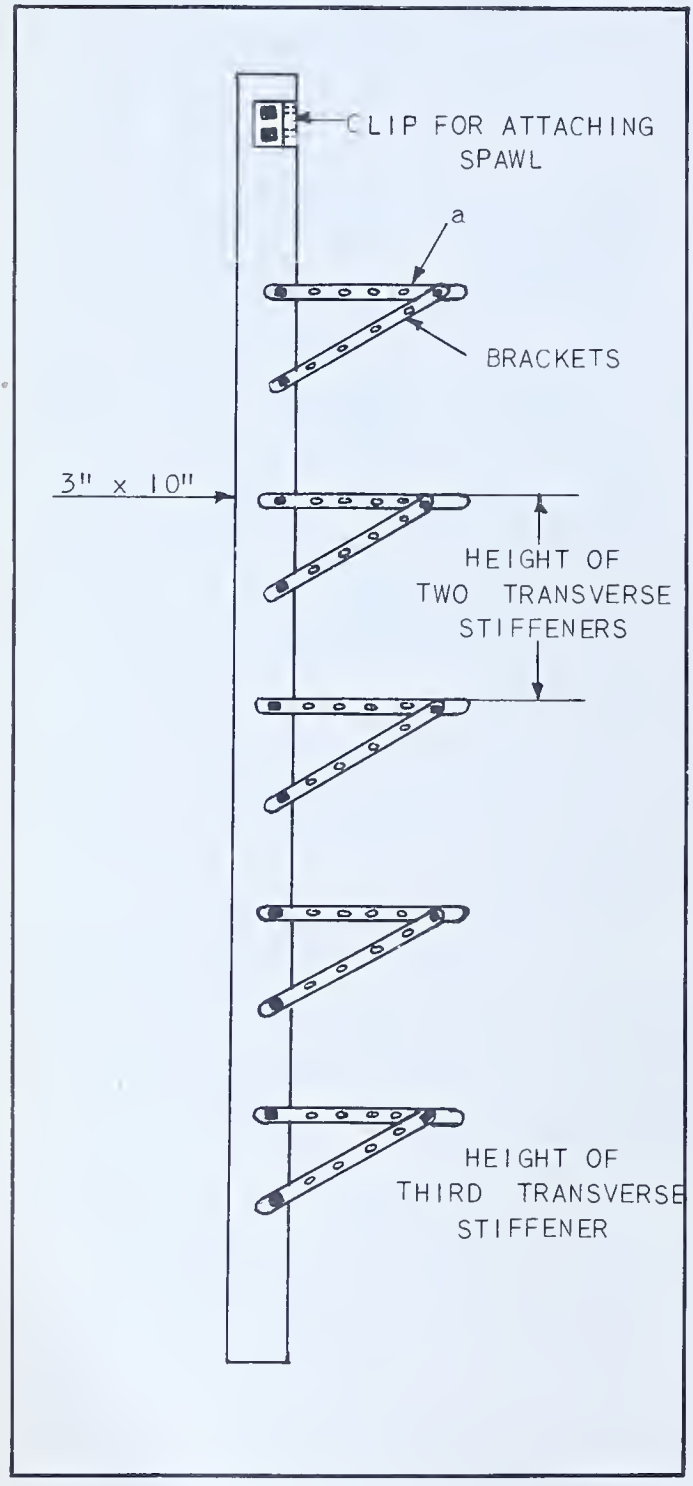


FIG. 95 — *Position of Figure 4 Brackets on an Upright*

F. Place the figure 4 brackets on the uprights. These are attached to the uprights by ¾" bolts.

The heights of figure 4 brackets are adjusted to suit the transverse or longitudinal stiffeners on the bulkheads.

G. Bolt the angle clips to receive the top spawl on the two end uprights.

Figure 96 shows the method of attaching the spawl to the top of the upright.

Figure 95 also shows the clip attached to the top of the upright.

5. Make the spawls long enough to reach across the top of the tank.

Two spawls run transversely across the tank. One runs across the after end, and the other runs across the center of the tank.

These spawls are placed at the top of the uprights and are used to support the planking which covers the entire tank. See Fig. 98. The spawls are made one foot shorter than the width of the tank; they are lapped and bolted in the center.

6. Place uprights one at a time.

The crane is used to place these uprights into position. They must be held by the crane until securely fastened.

7. Fasten the uprights in the tank.

The uprights are fastened on the bottom shell by one of two methods.

Wherever possible the upright is fastened to a longitudinal stiffener with hook bolts. Figure 99 shows this method. If this is not possible a clip is welded to the bottom shell and bolted to the upright. Figure 100 shows the use of the clip.

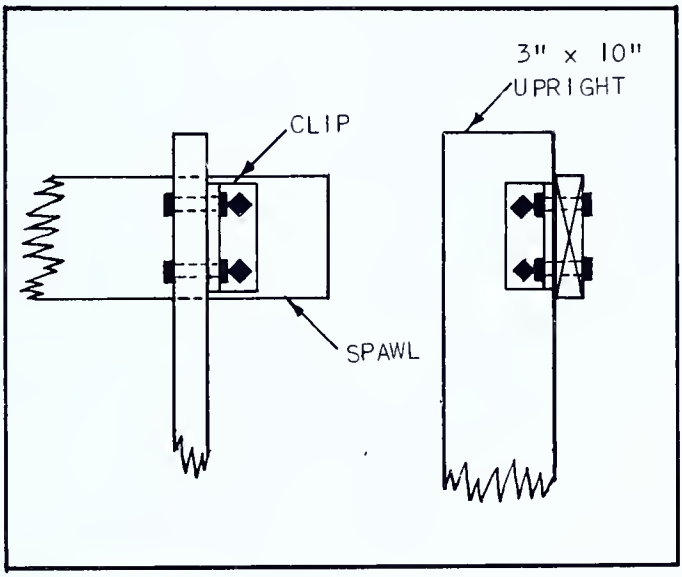


FIG. 96 — *Spawl Bolted to Upright*

FIG. 97 — *Typical Staging on Figure 4 Brackets*

All the intermediate uprights, or those located in the middle of the tank walls, are secured to the side shell by bolting to a clip which is welded to the side shell. (Fig. 101).

8. Plank the uprights.

9. Fasten the spawls for the top planking.

The center spawl is bolted directly to the center uprights, and it is supported in the center to the center girder which runs through the tank fore and aft. Figure 102 shows the method of support from the girder. The spawl at the after end is fastened to the clips which are attached to the top of the uprights. This is shown in Fig. 96.

10. Plank the top.

This is a double planking.

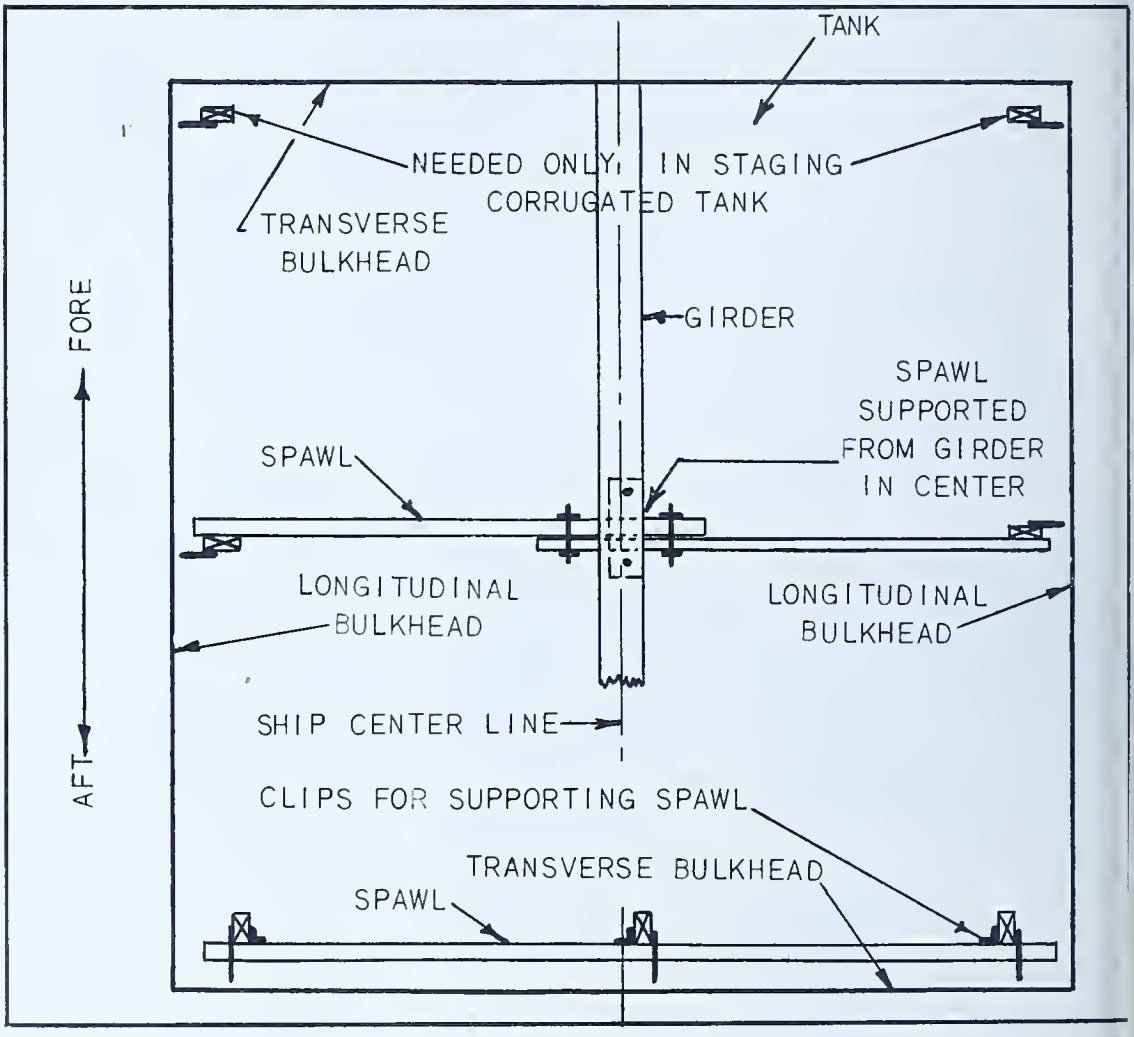


FIG. 98 — *Center Tank Staging*

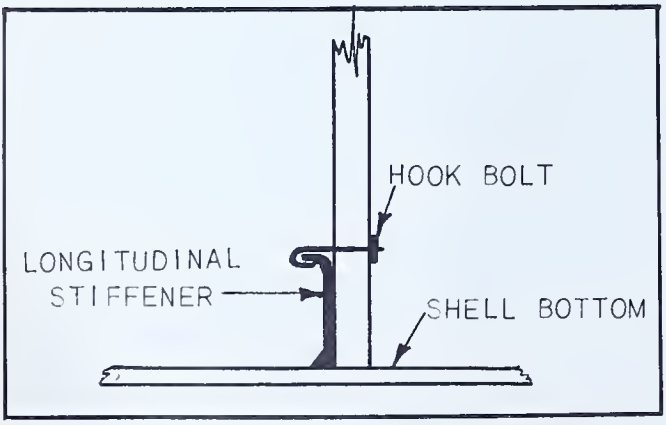


FIG. 99 — *Hook Bolt Securing Upright to Bottom Shell*

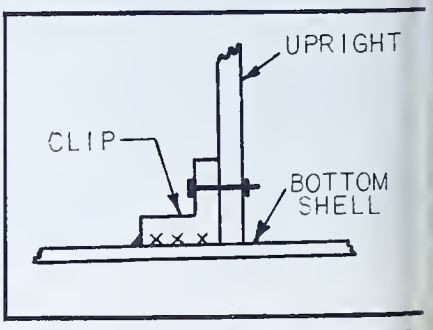


FIG. 100 — *Upright Fastened to Bottom Shell*

QUESTIONS

1. What is a spawl? How many are used in staging a center tank?
2. Why must spawls be used?
3. How are spawls attached to the uprights?
4. How is the height of each flight of staging determined in laying out the brackets on the upright?
5. How are the uprights secured before the crane is removed?
6. Explain why uprights are not all the same length.
7. How are the heights of the brackets on a corrugated tank determined?
8. What is the purpose of a clip?

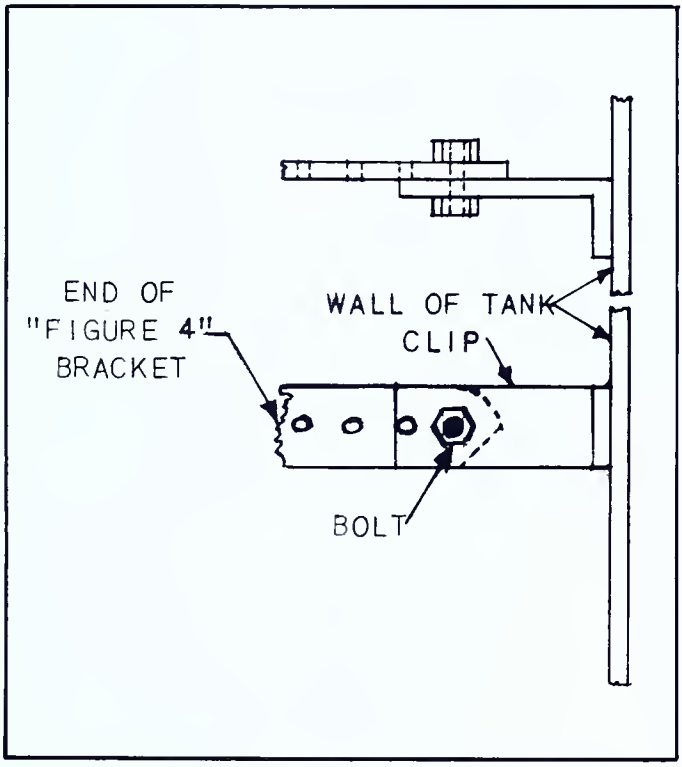


FIG. 101 — *Clip Welded to Side Shell*

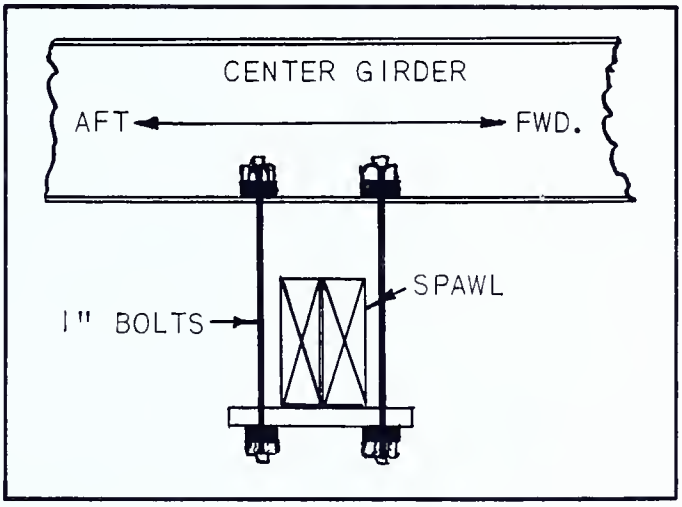


FIG. 102 — *Support for Center Spawl*

JOB SHEET NO. 15
STAGING THE WING TANKS

General Information

Because the longitudinal stiffeners of both the side shell and the longitudinal bulkhead are in alignment, they can be used as supports for the wing tank staging. The cross planks, therefore, rest on these ship members; and the lengthwise staging planks, in turn, rest on the cross members.

The simple matter of cutting and piling the planks is important. This procedure insures that each plank is placed in the position for which it was measured.

Special Safety Precautions

1. Measure the cross planks accurately so that they cannot slide off the longitudinal stiffeners. Replace any planks which are too short.
2. Climb the bulkheads carefully while measuring.

Tools and Materials

1. Two-man saw
2. Tape
3. Rope or tugger hoist

Procedure

1. Measure the length of each cross plank on each flight.
   (a) The cross planks run from the longitudinal stiffener of the outside shell to the longitudinal stiffener of the longitudinal bulkhead. See Fig. 103. Take measurements between these points.
   (b) Each cross plank is measured individually at the positions shown on Fig. 104.

Fig. 103 — *Wing Tank Staging*

(c) Begin measuring from the bottom and work up. Record the measurements on a sheet of paper.

(d) Exercise care in climbing and working on the bulkheads. Climbing is dangerous.

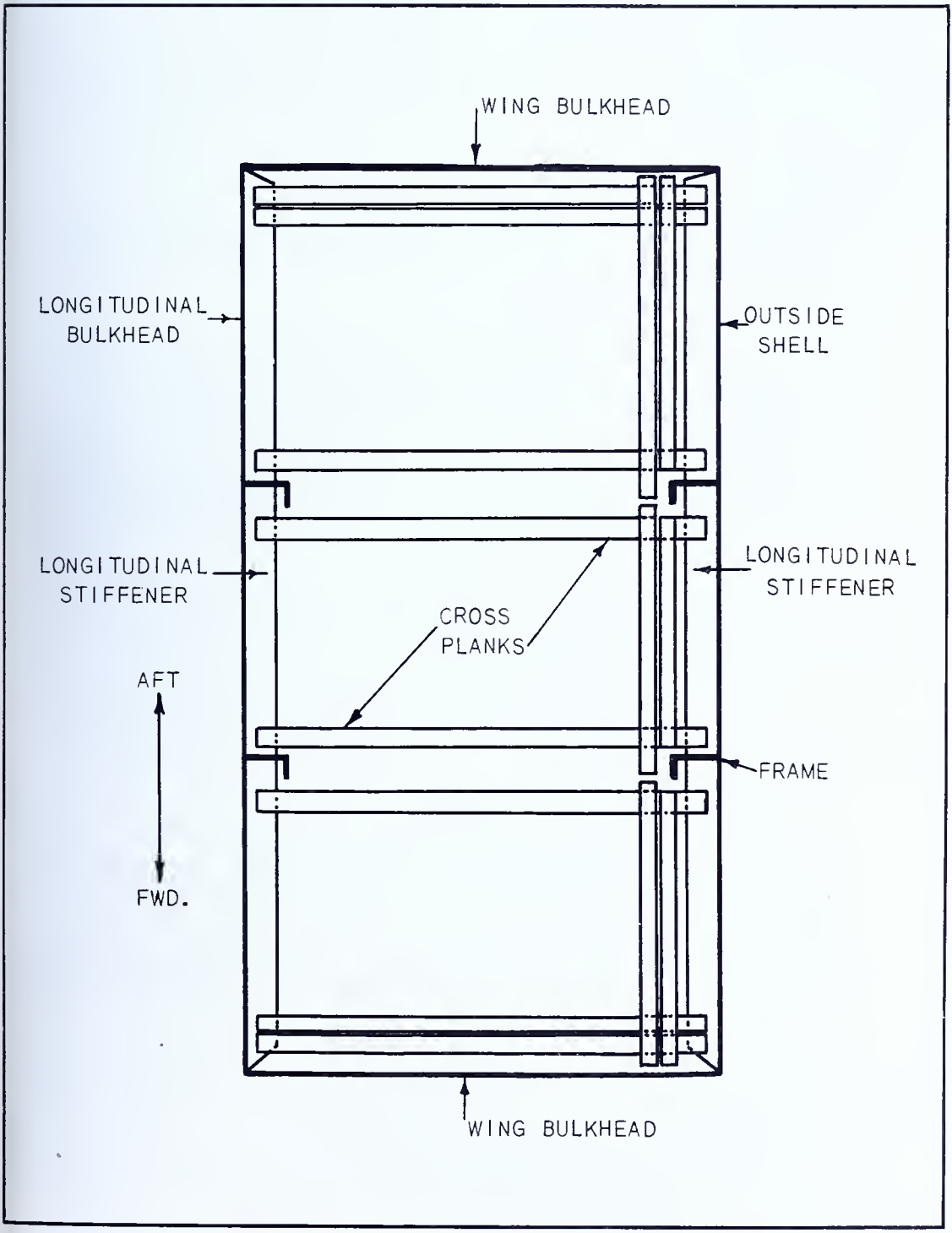


FIG. 104 — *Plan View; Wing Tank Staging*

2. Measure the length of the lengthwise planks. The measurements are taken from the positions of the figure 4 brackets Add about two feet to this length for overhang on the figure 4 brackets.

3. Determine and mark the height of the top flight of staging.

   The top flight of staging will come approximately below the deck, or six feet from the underside of the top shell. This height is six feet because it is a convenient height for working under the deck. It is also the height of the second stiffener below the deck.

4. Determine the location of the other flights of staging.

   The remaining flights of staging are placed approximately six feet apart according to the location of the longitudinal stiffeners on the side shell and on the longitudinal bulkhead.

5. Cut planks according to the measurements which were recorded on paper.

   It is important to cut the planks for the top flight first and to place them on a pile in the order of cutting. When the planking is placed, the planks for the bottom flight, which is planked first, will be located on the top of the pile, and can be easily moved into the tank in the order needed. Cut the planks in the order of measurement and mark the length of each piece before placing it on the pile.

6. Place the cut piles of planking at a convenient place on the deck.

7. Lay the cross planks on the bottom flight.

   Planks are lowered into the tank with a crane, tugger hoist, or a rope.

8. Lay two rows of lengthwise planks at right angles to the cross planks.

9. Plank each succeeding flight.

10. Plank the top flight, which is covered.

    The top flight of all tank staging is covered to permit men to work on the under side of the deck. It also aids other workmen in lowering pipe or other materials into certain positions in the tank.

    On ships not having longitudinal stiffeners, a spawl is bolted on the vertical stiffeners or frames to support the ends of the cross planks.

11. Procedure for removing the wing tank staging.

    (a) Place several planks across the frames near the bottom of the tank to protect the pipe fittings when planks are dropped.

    (b) Drop all planks to the bottom of the tank by means of a rope. Drop one plank at a time, starting from the top flight.

    (c) Remove planks through hatch openings with hoist.

    (d) Remove staging from fuel oil compartments and cofferdams similarly.

QUESTIONS

1. Why is the top flight of tank staging covered?
2. On boats not having longitudinal stiffeners, how are the cross planks supported?
3. Which flight of staging planks are cut first? Why?
4. How are the heights determined for the various flights of staging?
5. What procedure is used in lowering planks into the tank?
6. Explain the actual planking operation.

JOB SHEET NO. 16
STAGING THE OUTSIDE SHELL AT THE MIDSHIP SECTION

General Information

Staging towers are self-supporting towers which are the main supports for the outer staging of the ship. These towers can be moved in or out according to the size of the ship. Preliminary staging flights are 5 feet in height; if intermediate staging is necessary at any point on the shell, it must be built in later.

Notice the method used in laying the plank on the spawls. This method serves two purposes; it compensates partly for the declivity of the towers, and it also prevents excessive sliding of the planks.

Keep in mind also that spawls should not be placed against the ship shell.

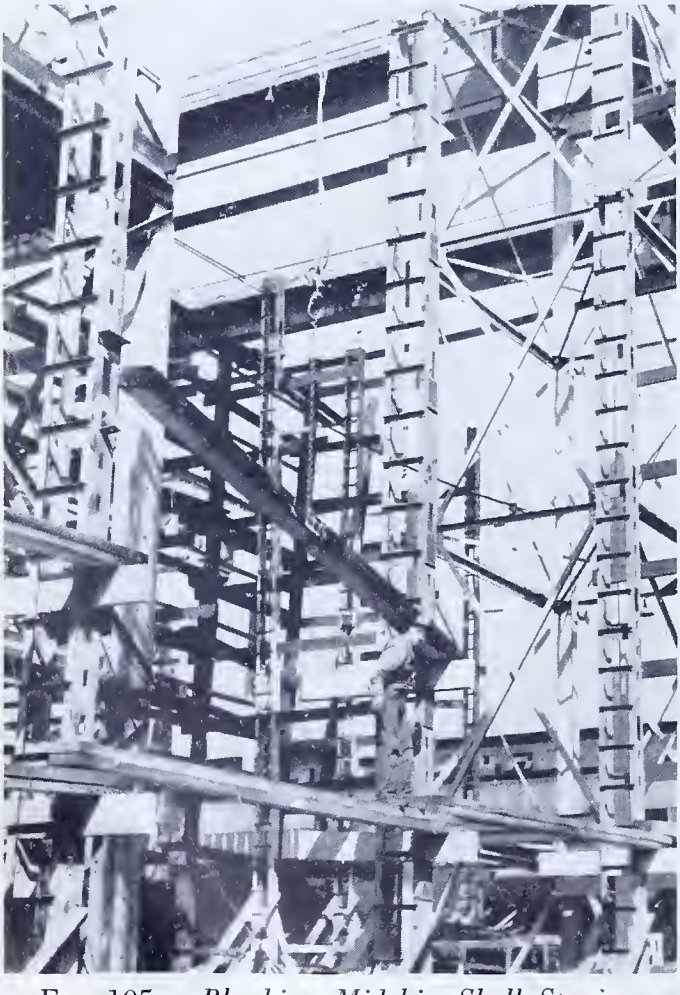


Fig. 105 — *Planking Midship Shell Staging*

Special Safety Precautions

1. One slip, when a workman is climbing about on staging, may mean serious injury. Inspect planking before walking on it; avoid leaning on or holding on to insecure planks or other unstable support.
2. Be on the alert for swinging loads of planks. A workman may easily be thrown off balance.
3. There is a right way and a wrong way to hook the chain when hoisting a plank. The chain must draw on the closed part of the hook. See Figs. 107 and 108.

Crane Signals

Signals for the raising or lowering of loads by means of the crane are given by the stage builders who have been authorized to do so. These signals are given by certain signs because spoken words cannot be clearly heard above the noise in the yard. A chart which indicates the several signs and their meanings will be found on Page 3.

Tools

1. Saw
2. Brace and bit
3. Wrench
4. 8-foot chain with ring and hook

Materials

¾″ bolts

Procedure

1. Find the width of the ship.

   This measurement is obtained from the stage building leader who determines the measurement from the general arrangement of the ship.

2. Allow, or add, 3′-6″ for the clearance between the ship and the staging towers.

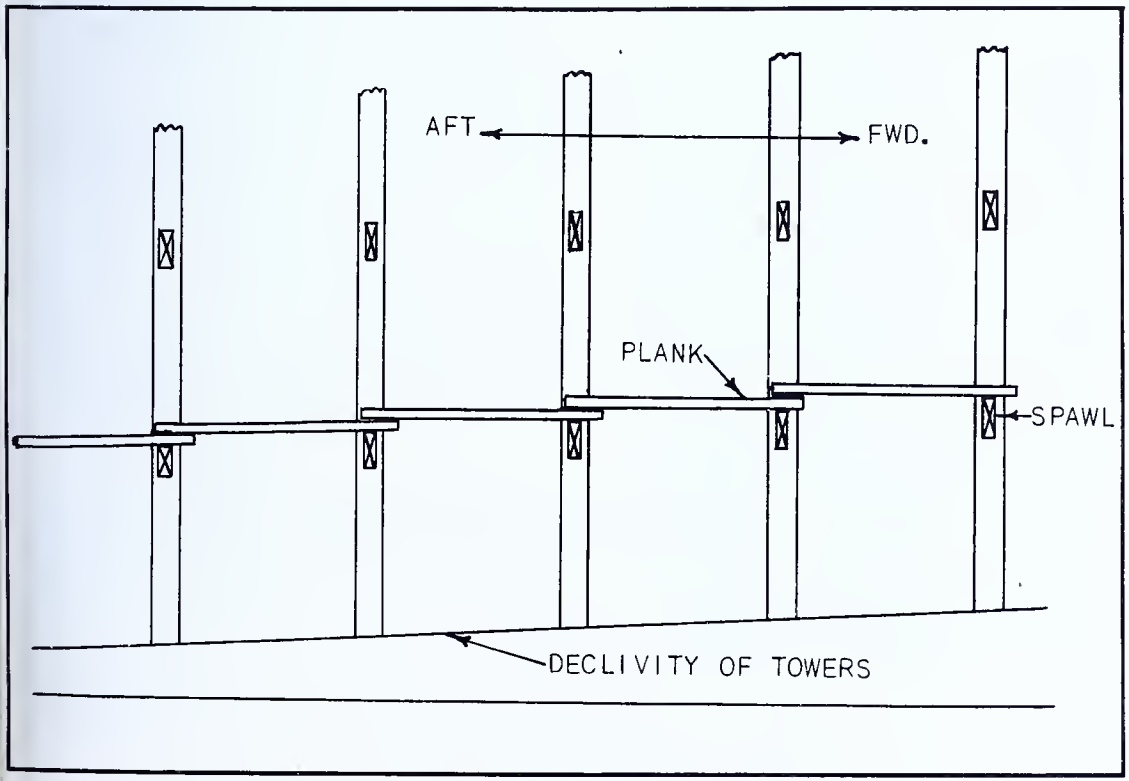


Fig. 106 — *Method of Laying Plank on Spawl*

3. Adjust the towers.

   The towers may have to be moved in or out according to the size of the ship. The towers are usually moved with a crane.

4. Place the spawls in the tower openings on the first flight of staging.

5. Plank the lower flight of staging.

   Start laying the plank at the after end and work forward. In this staging, the after end of each plank rests on the forward end of the plank; this procedure compensates for a part of the declivity between towers and also prevents excessive sliding of planks. See Fig. 106.

6. Repeat steps 4 and 5 at intervals of five feet until the deck height is reached.

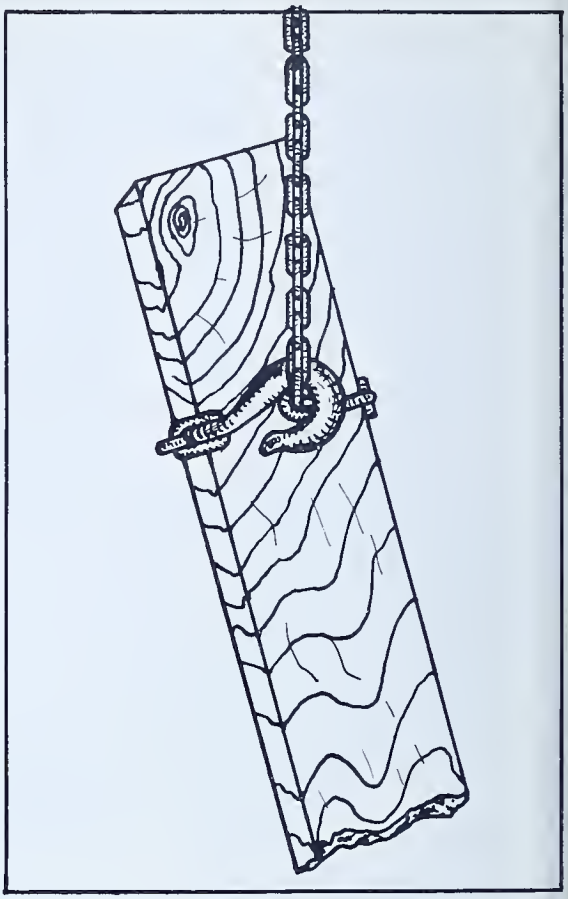


FIG. 107 — *Hook Cannot Slip*

7. When the shell is erected, adjust the spawls to the shell.

   The ends of the spawls should not be closer than 6″ to the shell of the ship. Placing them closer than 6″ makes it difficult for other craftsmen, particularly the painters, to do their work.

8. Place legs on the spawls which extend more than 5 feet beyond the tower. See Fig. 109.

   These legs support the spawls and at the same time act as a support for the guardrail.

9. Place the guardrails 3 feet above the staging planks.

   These guardrails are attached to the legs or directly to the staging towers by the use of clips.

QUESTIONS

1. Why are guardrails important members on the staging assembly?
2. Why is it necessary to know the width of the ship before setting the outside staging?
3. What is the purpose of the legs and when are the legs placed?
4. How far from the shell of the ship are the spawls placed?
5. What is the distance between flights of staging?
6. Explain how planks should be laid in planking this outer staging.

FIG 108 — *Right Way to Hook Chain*

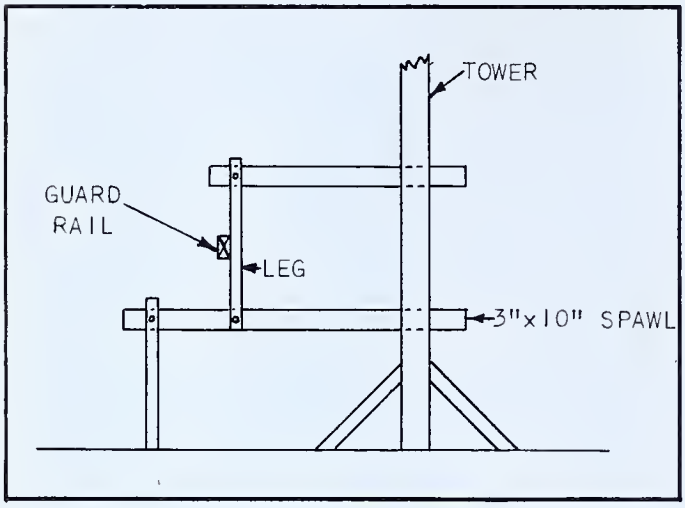


FIG. 109 — *Legs Supporting Long Spawls*

FIG. 110 — *Typical Port or Starboard Staging*

JOB SHEET NO. 17
SETTING STRUTS AND STAGING FOR THE AFTER END OF SHIP

General Information

Since the towers and struts are usually placed in position before the ship is raised it is necessary to determine the length of struts and the exact location of each tower. The layout procedure, as described in Job Sheet No. 18, must be made for each tower requiring a strut. The towers are usually moved into position with the crane and bolted down with $\frac{3}{4}$" x 12" lag screws.

The purpose of spreading the struts is to give the necessary strength and to facilitate easy placing of the spawls. See Fig. 111.

Spawls and planks are laid one flight at a time until the deck height is reached.

Special Safety Precaution

On this job the holes are bored with an air drill. Do not be careless with an air hose; it is dangerous.

Tools and Materials

1. Air drill
2. Bit
3. Wrench
4. Maul
5. Saw
6. Tape
7. Chain
8. Clips

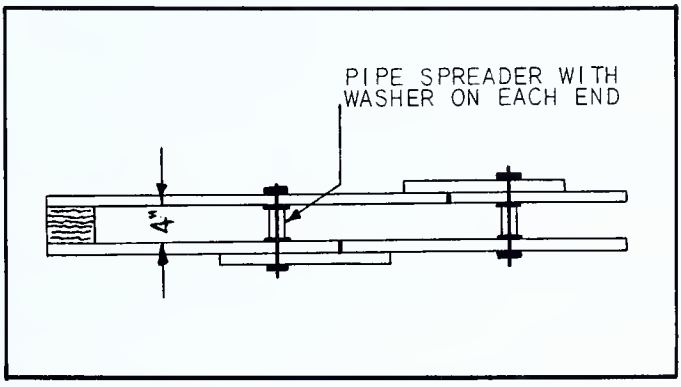


Fig. 111 — *Tower Strut*

Procedure

1. Lay out the length and position of tower struts.
   The procedure for this operation is discussed in Job Sheet No. 18.

2. Set the towers.
   Lift the tower into position, as determined on the scaled layout, and fasten the tower to the cap logs with $\frac{3}{4}$" x 12" lag screws.

3. Place a spawl on the tower at or below the point of intersection of the strut and tower. See Fig. 112.

4. Fasten spawl to tower.

   Since the top of the strut rests against this spawl, the spawl must be fastened so that it will not slide through the tower opening. Fastening the spawl is done by placing a pin through it in line with the inside of the tower.

5. Make the struts according to lengths determined on the layout. See Fig. 111.

   A. Select proper lengths of plank. Two lengths are needed for each strut.

   B. Join the planks together with butt joint and strap plates.

   C. Spread the two struts 4″.

      The two struts are spread at the bottom with a 4″ x 10″ x 12″ block and every 10 feet thereafter with pipe spreaders.

6. Place the struts into position with the crane.

   The position of the strut on the way is located from the scaled layout. The top of the strut falls into its exact location in the spawl previously placed.

7. Place the spawls on the bottom flight.

8. Secure the spawls to the strut.

   Level the spawls with the eye, drill a 15/16″ hole through the strut directly under the spawl, and insert a ¾″ staging pin through the hole from the after side. The hole is drilled 3/16″ oversize to prevent the bolt's binding after dampness causes the bolt to rust. The end of the spawl then rests on the staging pin.

9. Plank the bottom flight.

   Repeat steps 7, 8, and 9 on succeeding flights until the deck height is reached

10. Place guardrails, using clips for their support. See Fig. 102.

QUESTIONS

1. **Why is it necessary to know certain half-breadth measurements of the ship for this operation?**
2. **From where are the half-breadth measurements of the ship obtained?**
3. **How is the distance of the tower from the ship determined?**
4. **What is a strut?**
5. **From which side of the towers are the spawls placed?**
6. **Why are guardrails necessary on this staging assembly?**

JOB SHEET NO. 18
LAYING OUT THE LENGTH AND POSITION OF TOWER STRUTS

General Information

Two important measurements are secured from this layout job: first, the actual length of the strut; and second, the distance that the strut is placed from the center line of the ship. The layout is to a scale of 1″ to 1′-0″, which means that one inch of measurement on the layout equals one foot of measurement on the strut. The layout cannot be made until the half-breadth measurements of the ship at certain specified water lines are known.

The measurements must be known for each strut that is to be placed.

Studying Fig. 112, along with the explanatory material, will help considerably in the understanding of the procedure.

Tools and Materials

1. Tape
2. Pencil
3. Straightedge

Procedure

1. Secure the half-breadth of the ship at the nearest frame to each staging tower requiring a strut.

   The 12′, 24′, 32′ and upper deck water line measurements are important. These measurements are obtained from the mold loft.

2. Select a smooth, flat surface for laying out struts.

3. Draw the center line of the ship. See Fig. 112.

4. Draw the following lines at right angles to the center line. See Fig. 112.

   I. Line representing the base line.

   II. Lines representing the height of the:

   (a) Keel blocks
   (b) 12-foot water line.
   (c) 24-foot water line
   (d) 32-foot water line
   (e) Upper deck line

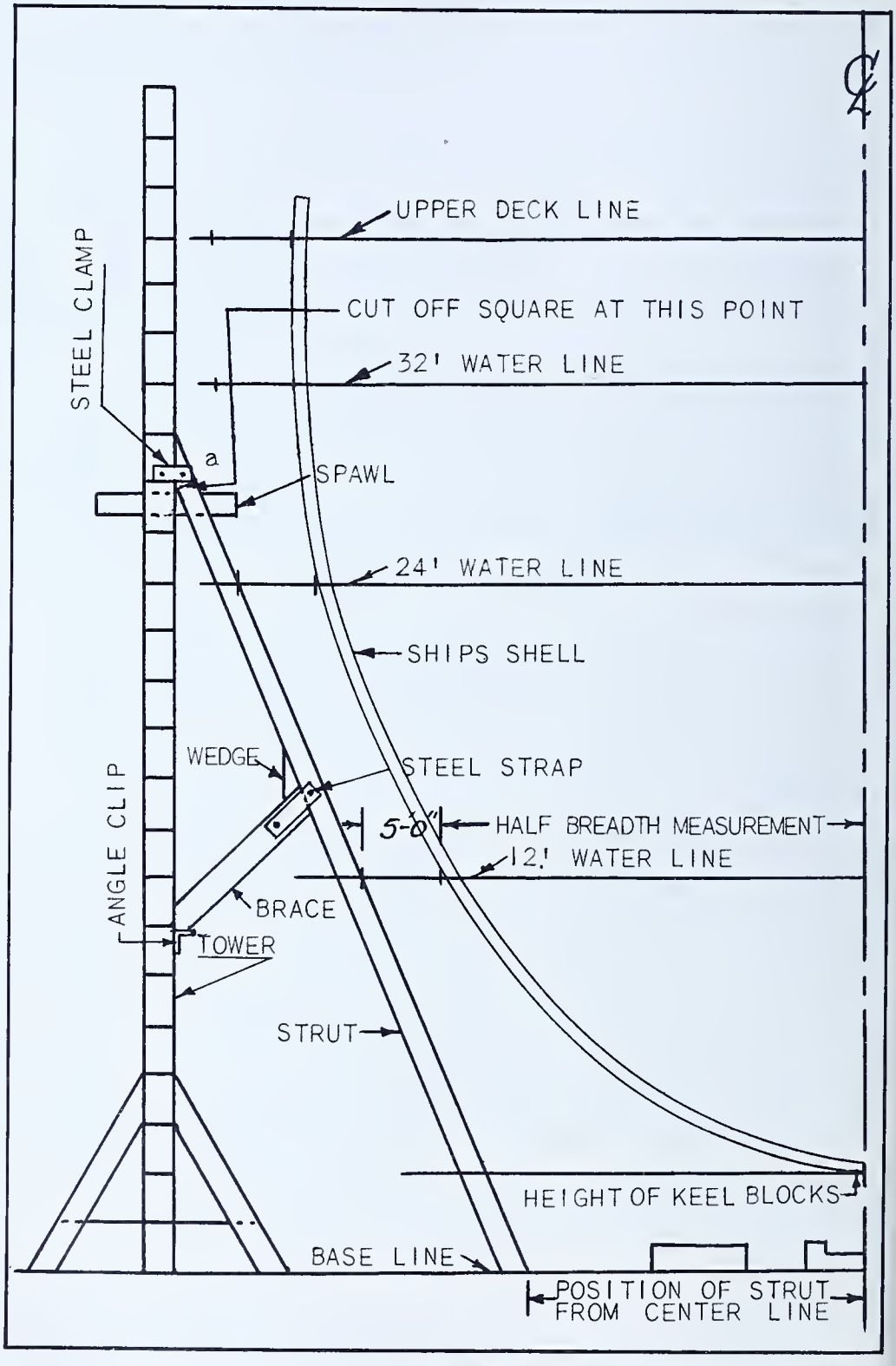


FIG. 112 — *Lay Out for Determining Length and Position of Struts*

5. Draw in the staging tower.

6. From the center line, measure and mark the given half-breadths. See Fig. 112.

7. Add 5 feet to each half-breadth mark.

   The tower struts must be at least 5 feet from the ship shell in order to have proper clearance.

8. Draw a straight line through the outermost points until it intersects with the tower.

   Since the strut is a straight support, the line drawn in step number 6 will not pass through all points which have been established. The intersection of the strut and the tower shows the position of the tower.

9. Draw in the exact width of the strut.

   A. The strut is made from 3″ x 10″ plank.

   B. The point where this line intersects with the staging tower is the point where the strut should be cut off square. See Fig. 112 at "a".

10. Measure the length of the strut and the distance it will be located from the center line of the ship. See Fig. 112. Since the above layout is drawn to a 1″-1′ scale, the scaled drawing can be measured and this measurement transferred to feet.

    NOTE: The same layout procedure must be followed for each particular strut.

QUESTIONS

1. **What is a mold loft?**
2. **Why are the water lines needed?**
3. **Why are 5 feet added to the half-breadth measurements?**
4. **How are the strut angle and length determined?**
5. **Explain the value of struts.**

JOB SHEET NO. 19
SETTING, SHORING, FASTENING, AND PLUMBING STERNPOST

General Information

The sternpost is located at the after end of the ship. It is a massive casting which forms the bearing for the propeller shaft and rudder. The casting itself is made of three parts which are welded together before it is set.

Study the photograph of the sternpost to become familiar with the various parts, namely, rudder carrier and gudgeons. Knowing the location of these parts on the stern will help a great deal in understanding the operations involved in setting the post.

Sternposts weigh as much as 25 tons; therefore, shores must be of good, solid material, and they must be grounded well. Cables and clips must also be fastened securely.

Since the stage builder is responsible for keeping the sternpost plumb, it is very important to check it frequently until it has been closed in with supporting members.

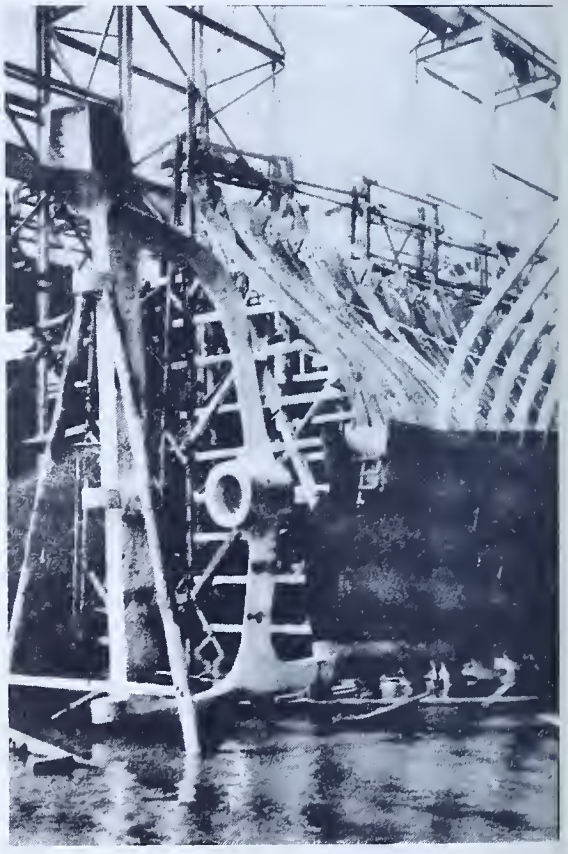


Fig. 113 — *Sternpost*

Special Safety Precaution

While the sternpost is being held by the crane, the stage builder must climb to the top of the post to insert the chain of the auxiliary hoist through the rudder carrier.

Since the after end of the way is wet, footing is usually poor. Extreme caution must be exercised to prevent a dangerous or perhaps fatal fall.

Tools and Materials

1. Chain
2. Plumb bob
3. Maul
4. 50-ton screw jack
5. Saw
6. Rounding piling shores
7. Wire cables
8. Tape

OTHER MECHANICS NEEDED: Erectors and Welders.

PROCEDURE

1. Have the welder attach two clips underneath the rudder carrier.

   One clip is welded on each side. This is always done while the sternpost is on the ground.

2. Attach the cables to the clips.

   This, too, is done before the sternpost is erected.

3. Determine the length of shores needed.

   The length of shores can be determined by measuring the distance from the top gudgeon to the base line. The shores must be cut before the stern is erected so that they will be ready for placing when needed.

4. Cut the two shores.

5. Weld a flat bar of steel lengthwise on the top of the rudder carrier.

   The edge of the bar is placed to coincide with the center line marking on the top of the rudder carrier. The stage builder locates the exact position of the bar for the welder. The purpose of the bar is to extend the center line of the rudder carrier so that a plumb bob can be hung from this point.

6. Have the erectors place the sternpost on the keel blocks.

7. Fasten the cables to the base of the crane columns.

   Two cables run at right angles to the sternpost while the others run obliquely toward the forward end of the ship.

8. Plumb the sternpost transversely.

   (a) Drop a plumb bob from the edge of the flat bar on the top of the rudder carrier to the center line in the gutter.

   (b) Adjust the cables until the plumb bob strikes the center line.

   Ratchets are used to draw the cables.

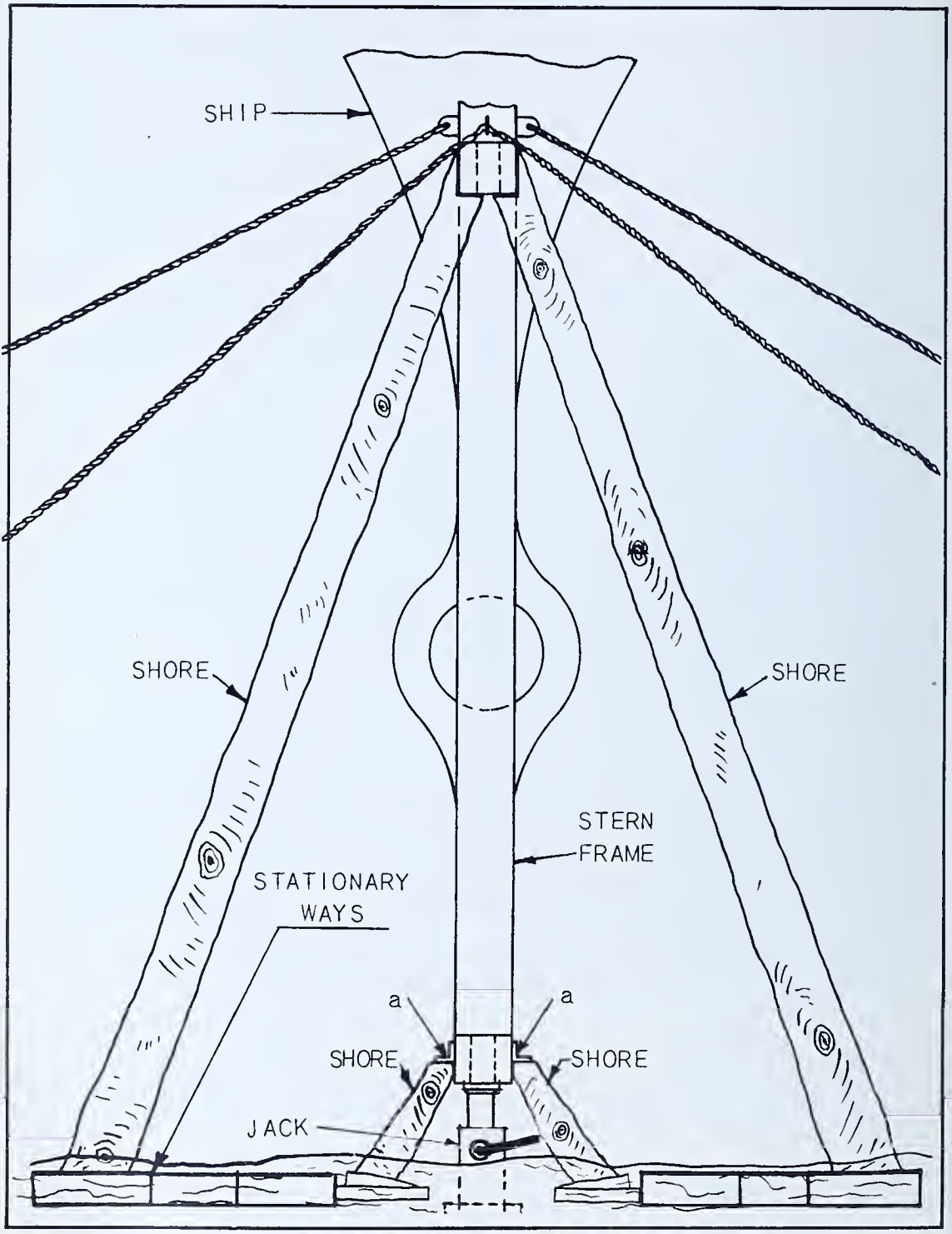


FIG. 114 — *Shoring a Sternpost*

9. Plumb the sternpost for declivity.

   (a) Determine the declivity.

   The amount of declivity is determined by multiplying the height (in feet) from the top of the rudder carrier to the top of the "bottom rudder gudgeon" by the amount of declivity per foot.

   (b) Place a 50-ton jack under the sternpost near the after end of the stern.

   (c) Reset the plumb bob.

   (d) Raise the jack until the declivity distance is reached.

   The distance of declivity is measured from the plumb line to the center punch mark on the top of the "bottom gudgeon".

10. Shore the bottom of the sternpost with spur shores. Figure 114 shows the clips and the spur shores in position.

    (a) Weld a clip on each side of the sternpost, as shown in Fig. 114 at "a".

    (b) Cut a heavy, round piling shore.

    (c) Place shores.

11. Re-check the work to make sure the sternpost is plumb.

12. Place long shores, previously cut, to the underside of the top gudgeon.

    These shores are pulled into position with the auxiliary crane. Figure 114 shows how the long shores are notched to fit the gudgeon.

13. Tighten cables and shores securely.

14. Re-check to make sure the sternpost is plumb.

15. Release the crane.

16. Re-check the work at frequent intervals to make sure the sternpost is plumb. This should be done every few days until the stern is closed in securely. This is important.

QUESTIONS

1. Why is a straight flat bar of steel plate welded to the top of the rudder carrier?
2. What is a clip?
3. How is the declivity distance of the stern determined?
4. Where are the guy wires or cables fastened, and how do they aid in plumbing the sternpost?
5. Describe the manner in which the sternpost must be "plumbed".
6. Point out the method used for each plumbing operation.
7. If the distance from the top of the rudder carrier to the top of the "bottom rudder gudgeon" is 32′ 6″ and the declivity of the ship way is 13/16″, what is the declivity measurement on the sternpost?
8. Why should the sternpost be checked frequently?
9. Why are the stern shores cut before the stern is erected?
10. When can the checking of the sternpost be discontinued?

JOB SHEET NO. 20
SETTING STRUTS AND STAGING FOR THE FORWARD END OF THE SHIP

General Information

The procedure for laying out struts and for setting towers on the forward end of the ship follows the same plan as described in Job Sheets Nos. 17 and 18. Struts are laid out and placed; the towers are located in their exact position and planked.

As each strut is laid out, determine whether or not it will fall in the path of the sliding launch way. If it does, the strut must be moved backward or forward to miss the launch ways. This is of particular importance when staging the forward end of the ship, since the launch ways are slid under the ship from the bow end.

The forward end of the ship must be well staged to facilitate working at the bow. Since the staging from the two sides of the ship converge at the forward end, individual end towers cannot be used to support the staging. Bow towers, shown in Fig. 116 are used to support the end planks.

Tools and Materials

1. Drilling machine
2. Impact wrench
3. Maul
4. Drift bar
5. Saw
6. Bolts

Procedure

1. Determine which towers need struts.

2. Lay out the length and position of the struts.

   Follow the procedure in Job Sheet No. 17, "Setting Struts and Staging for the After End of the Ship."

3. Determine which struts fall in the way of the launch ways.

   Launch ways are slid under the ship from the bow end; therefore, the struts must not be in their way. Those struts which do fall in the line of the launch ways must be moved either forward or backward. In some cases struts are cut off and legs attached as shown in Fig. 117.

FIG. 115 — *The Bow of a Ship Staged-In*

4. Set the towers, spawls, and planks. See Fig. 116.

   This operation follows the same procedure as in Job Sheet No. 18, "Laying Out the Length and Position of Lower Struts." See Fig. 112.

5. Place the bow tower. Figure 116 shows the bow tower and spawls.

   The bow tower is made by placing two towers transversely side by side at the forward end of the way. The two towers are approximately 10 feet apart. Spawls run through the towers at the various flight heights to support the end planks from the two converging sides of staging.

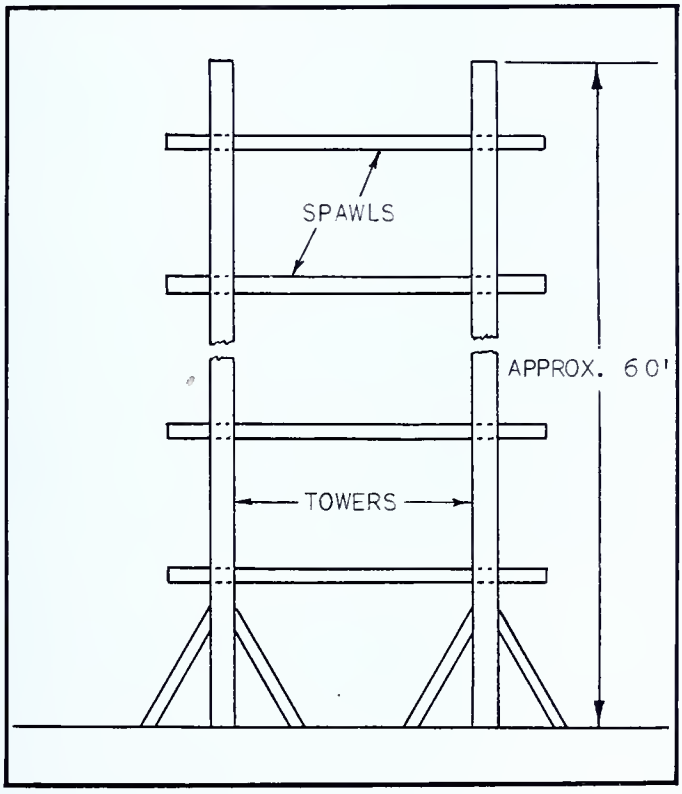


FIG. 116 — *Bow Tower*

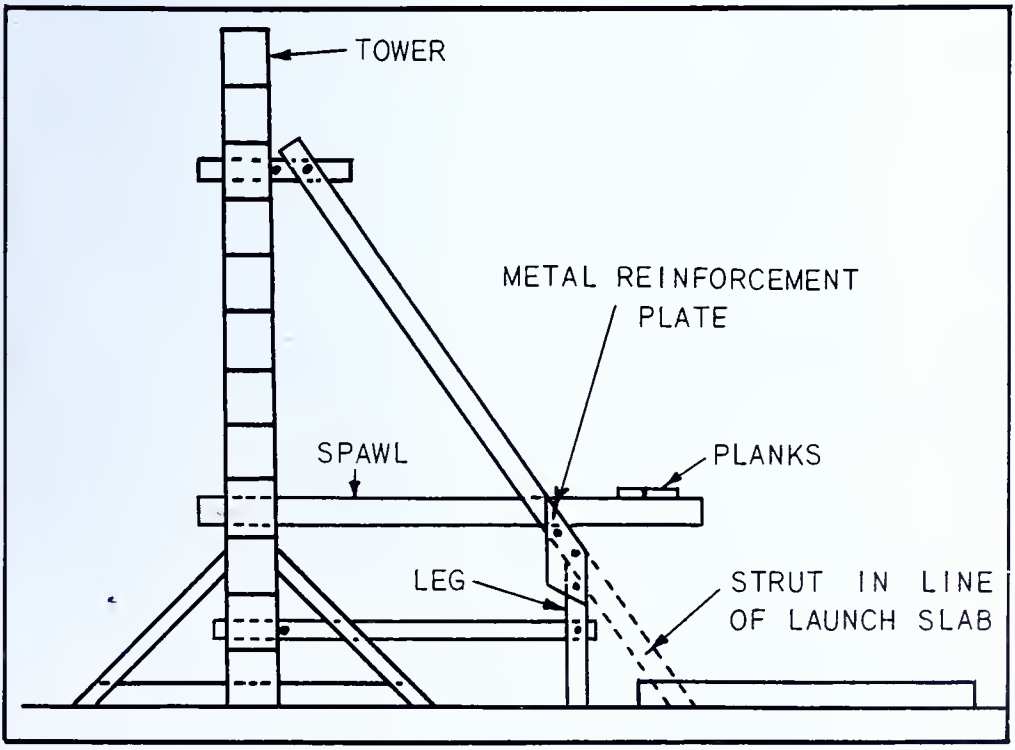


FIG. 117 — *Tower Spawl With Leg*

QUESTIONS

1. Are strut legs used in staging the forward end of the ship?
2. How are they treated?
3. Explain the purpose of the bow tower.
4. Explain the procedure for laying out the length of the tower struts.
5. Approximately how far apart are bow towers placed?
6. Are legs needed to support spawls on bow towers?

FIG. 118 — *Bow Staging*

JOB SHEET NO. 21
STAGING THE ENGINE AND BOILER ROOM

General Information

The engine room is open in the center so that engines and boilers can be moved into the ship. The initial staging, therefore, is placed for assembling the hull of the room and for working under various decks or flats of the room. The spans of staging are made as short as possible because the engine-room staging must frequently be moved to accommodate such installations as the main engine, pumps, switchboards, condensers, boilers, valves, pipes, wiring, etc.

Each deck or flat is staged separately and at a convenient height for working under the deck. Since there are few horizontal stiffeners on the engine-room walls, such supports as clips, angles, and figure 4 brackets must be used as supporting members.

A guardrail is an essential part of the staging. It should be placed on each flight around the center opening.

Special Safety Precaution

Be careful not to drop tools or materials; other men are usually working underneath.

Tools and Materials

1. 6-ft. rule
2. Hook bolts
3. Open-end wrench
4. Saw
5. Clips
6. Angles
7. Brace and bit

Other Mechanic Needed: Welder.

Procedure

1. Locate the position of the angles on the stanchion and the opposite web frame. See Fig. 119.

   The angles are located approximately 6 feet below the deck. Locate one angle on the stanchion and one on the web frame opposite. The number of spawls necessary is determined by the length of the room. The spans are always made as short as possible.

2. Have the angles welded to the stanchion and frame.

   The angles are usually 10 to 12 inches in length; and, when welded in position, they extend several inches beyond the stanchion or frame to support the spawls. Figure 119 shows how the spawls extend beyond the stanchion.

3. Locate the weld clips on all stanchions and webs.

4. Lay spawls on the angles. See Fig. 119.

   These spawls run from a web frame to a stanchion. They are 3″ x 10″ plank placed edgewise and running several feet past the stanchion to support the lengthwise planks.

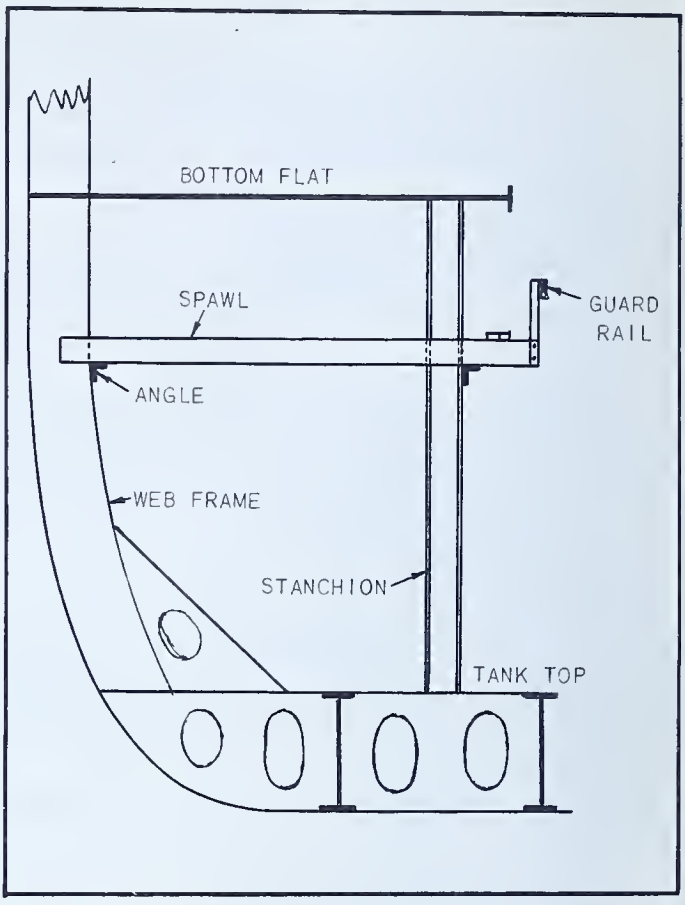


FIG. 119 — *Method of Supporting Spawl In Engine-Room Staging*

5. Fasten the spawls with hook bolts.

6. Provide staging supports for the forward and after bulkheads.

   The staging planks for the forward and after bulkhead walls are supported by clips and figure 4 brackets which are welded to the bulkhead at the same height as the spawls. See Fig. 120.

7. Plank the forward and after ends.

   Follow the usual procedure for planking, that is, work from the bottom flight up.

8. Plank the staging on the spawls.

   The end planks rest on the transverse bulkhead staging. Figure 120 shows the method of planking the corners.

9. Place rails around the center opening.

   See Fig. 119.

10. Repeat the same procedure for each deck.

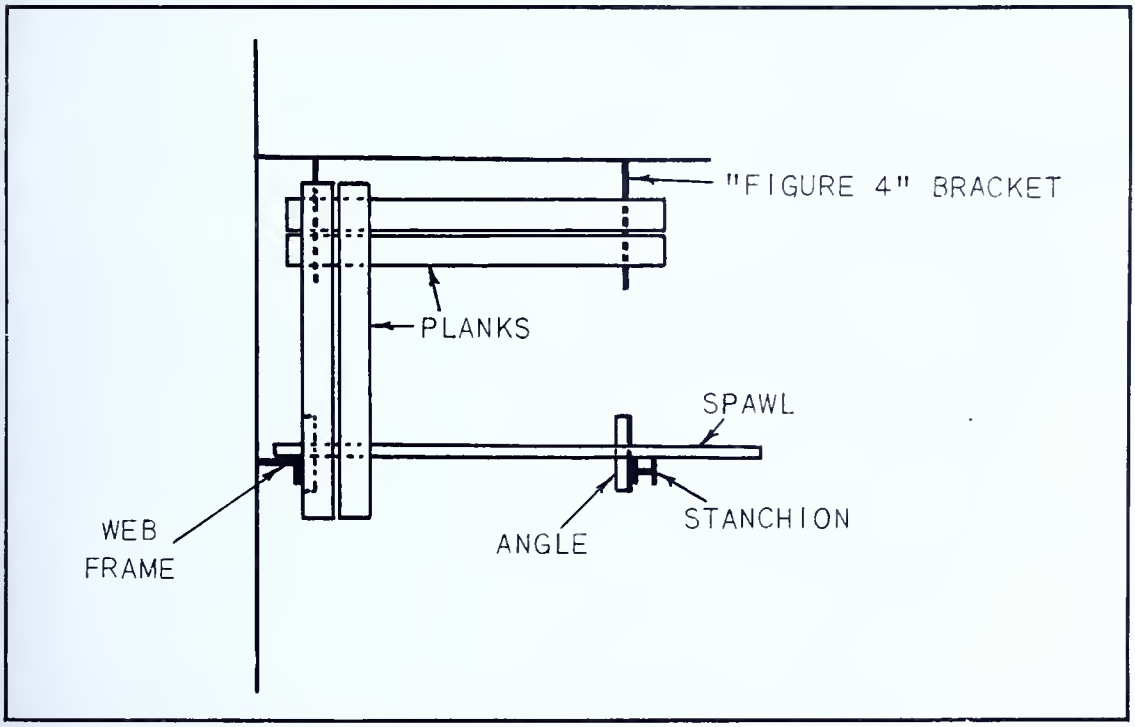


FIG. 120 — *Plan View of Corner Staging in Engine Room*

QUESTIONS

1. **Why are the spans of staging made as short as possible?**
2. **Why are uprights not used as supporting members in staging the engine room?**
3. **What is a stanchion?**
4. **How are the spawls held securely in position?**
5. **Why is the engine-room staging a relatively permanent staging?**
6. **What supports the last set of planks running fore and aft in the engine-room staging?**
7. **On the forward end after bulkheads, what are the supporting members for the planks?**

JOB SHEET NO. 22
STAGING THE DRY CARGO HOLD

General Information

One flight of staging is necessary to accommodate welder and chippers under the decks. The height of the staging below the decks is approximately 6 feet, depending on the location of the longitudinal stiffeners. The dry cargo hold is staged mainly to accommodate workers under the deck. It is necessary, therefore, to erect one flight of staging approximately 6 feet under the deck. If it is necessary to work under this flight of staging, the method shown in Fig. 121 is usually followed. Angles three feet in length are bolted to the longitudinal stiffeners, and planks are placed across the angles.

Another type of staging, for use when working under the deck, is shown in Fig. 119.

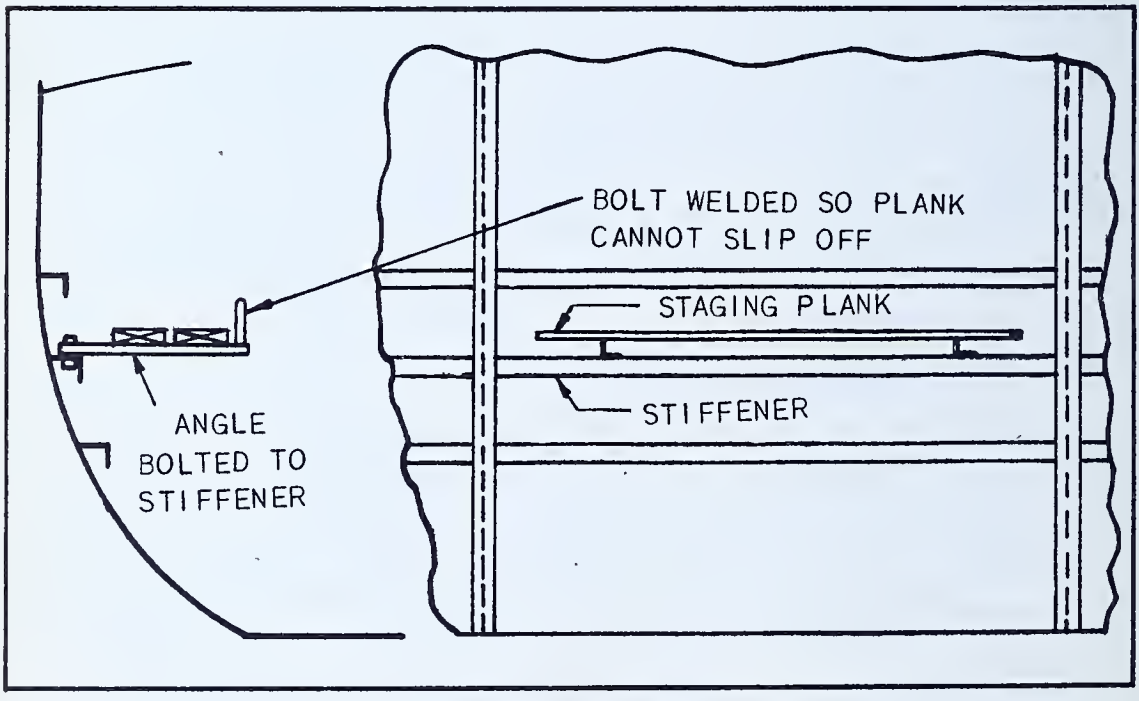


Fig. 121 — *Small Staging in Cargo Hold*

Tools and Materials

1. Saw
2. Brace and bit
3. Wrench
4. Clips
5. Bolts
6. Rope

Other Mechanic Needed: Welder.

PROCEDURE

1. Establish a convenient height for the staging.

   This height should be approximately 6 feet below the deck to accommodate the workers under the deck. Wherever possible, it is placed at the same height as the longitudinal stiffeners on the side shell.

2. Divide the room transversely into three equal spaces. See Fig. 122.

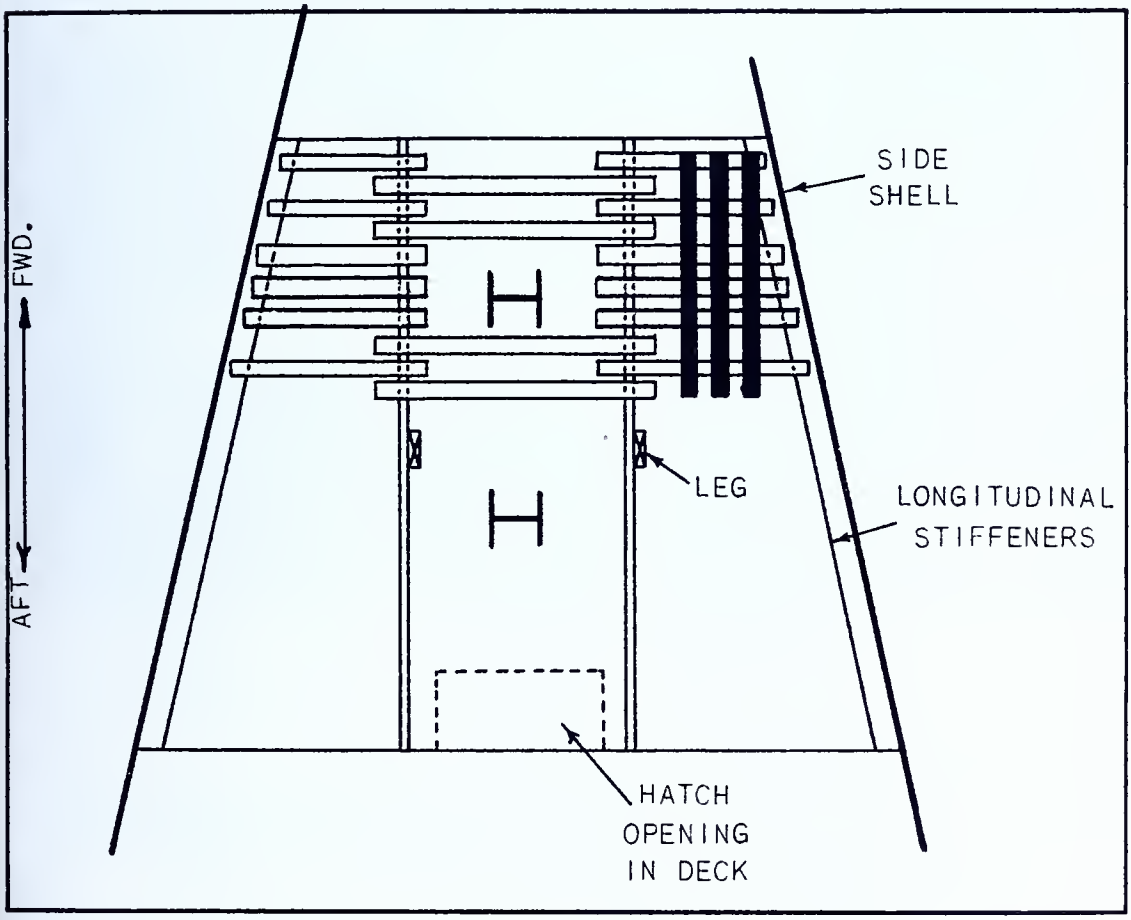


FIG. 122 — *Staging in Cargo Hold*

3. Make two spawls the same length as the room.

4. Weld the clips at the predetermined height of the staging.

   The clips must be of sufficient length to receive the strap bolts which are used to fasten the spawl.

5. Place the two spawls on the clips.

6. Strap the ends of the spawls to the clips as shown in Figs. 123 and 124. The strap prevents the spawl from sliding off the clip or from turning over.

7. Bolt a leg in the center of each spawl.

8. Plank the entire space transversely.

   Lay planks across the spawls and from the spawls to the longitudinal stiffeners. The planks are laid approximately 2 feet apart.

9. Lay the top planking in a fore-and-aft direction.

   Figure 122 shows the cargo hold partly planked.

10. Place a ladder at the after end of the hatch opening in the deck.

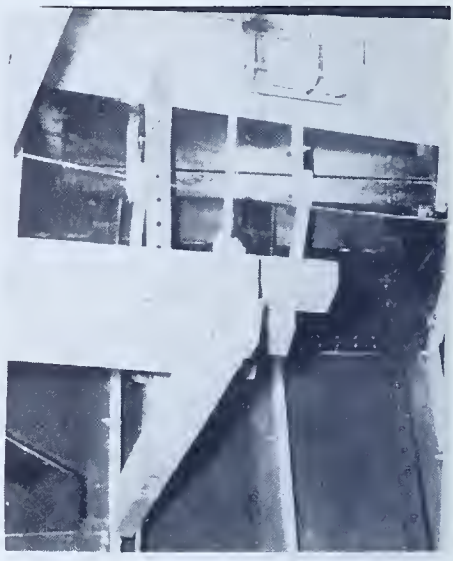


FIG. 123 — *Showing Staging Plank Supported by a Spawl*

PROCEDURE FOR REMOVING CARGO HOLD STAGING

1. Lower planks to the deck.

   Lower one plank at a time, and pile near the hatch opening.

2. Remove legs from spawls.

3. Remove straps which hold spawls to clips.

4. Take down spawls.

   Lower spawls to deck by throwing a rope over a beam.

5. Take spawls apart and remove with a crane.

6. Remove the figure 4 brackets and clips.

   Brackets and clips are removed by the burner. The stage builder must work with the burner at all times to hold ladders and to assist him in other ways.

7. Remove the piles of planking with the crane.

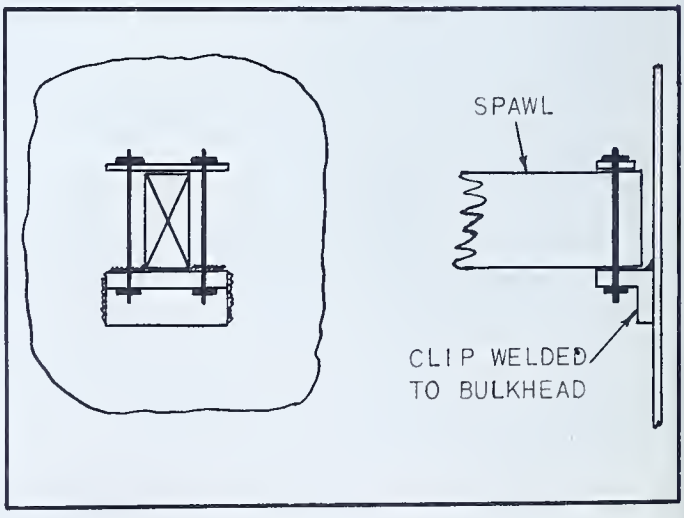


FIG. 124 — *Spawl Strapped to Clip*

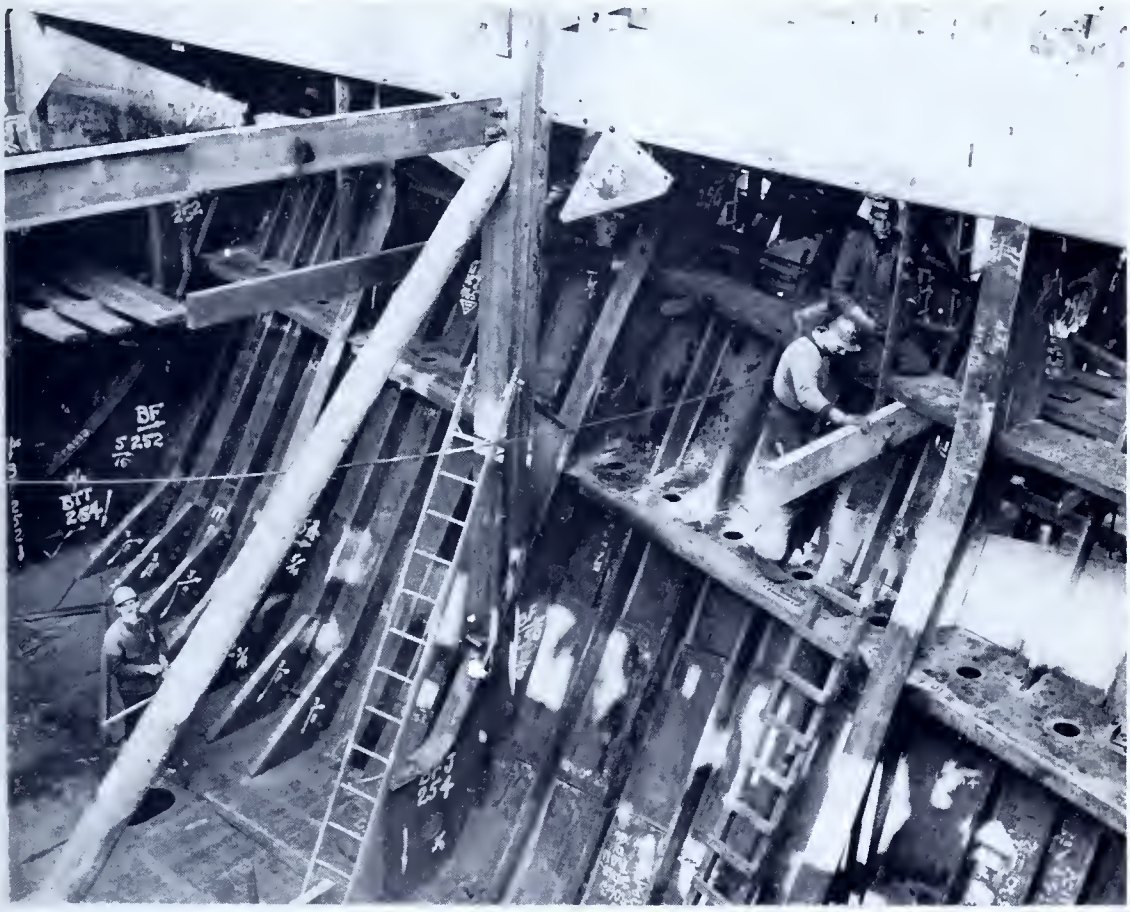


FIG. 125 — *Staging Inside the Hull*

QUESTIONS

1. How many flights of staging are necessary in the cargo hold?
2. What members support the planks of the cargo hold staging?
3. How are spawls supported or fastened at the ends?
4. What support does the spawl have other than the end clips?
5. List the steps in removing the cargo hold staging.

JOB SHEET NO. 23
STAGING THE CHAIN LOCKER

General Information

The chain locker room is a small, deep room approximately 6 x 10 ft. in size. A bulkhead divides the space into two smaller lockers. The purpose of each locker is to store the anchor chains. A small, watertight door at the top of the tank permits workmen to enter the locker for painting, cleaning, and repairs. Whenever possible, the chain locker should be staged before the deck is laid.

In staging assembly of the chain locker, the uprights cannot rest on the bottom plate of the locker because a concrete, funnel-shaped floor is laid in this compartment before the staging is removed.

All spawls throughout the assembly might be attached with clips. The disadvantage of this method is that a great deal of time is necessary to place and remove the clips. Use a drop bolt in the ends of the planking to prevent spawls from sliding. See Fig. 126.

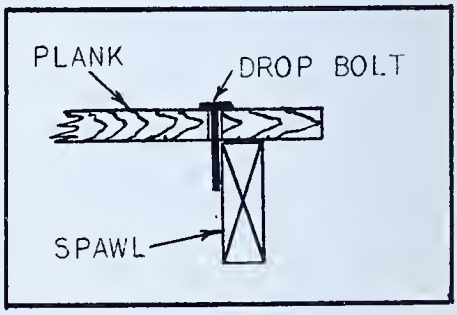


Fig. 126 — *Using a Drop Bolt to Prevent Spawls Sliding*

Special Safety Precaution

One man should never work alone in any tank. The only openings in the chain locker tank are a small water-tight door and a 12″ x 16″ opening to receive the chain.

If a lone worker were injured in such a compartment, he would have difficulty securing assistance from outside workmen.

Tools and Materials

1. Saw
2. Rule
3. Clips
4. Bolts
5. Wrench
6. Brace and bit
7. Drop bolts

Other Mechanic Needed: Welder

PROCEDURE

1. Determine and mark the heights of the flights of staging.

   Starting at the underside of the forecastle deck, measure and mark intervals of six feet.

2. At the established marking of the bottom flight of staging, attach clips to the longitudinal bulkhead approximately 6″ from the transverse bulkhead, as shown in Fig. 127.

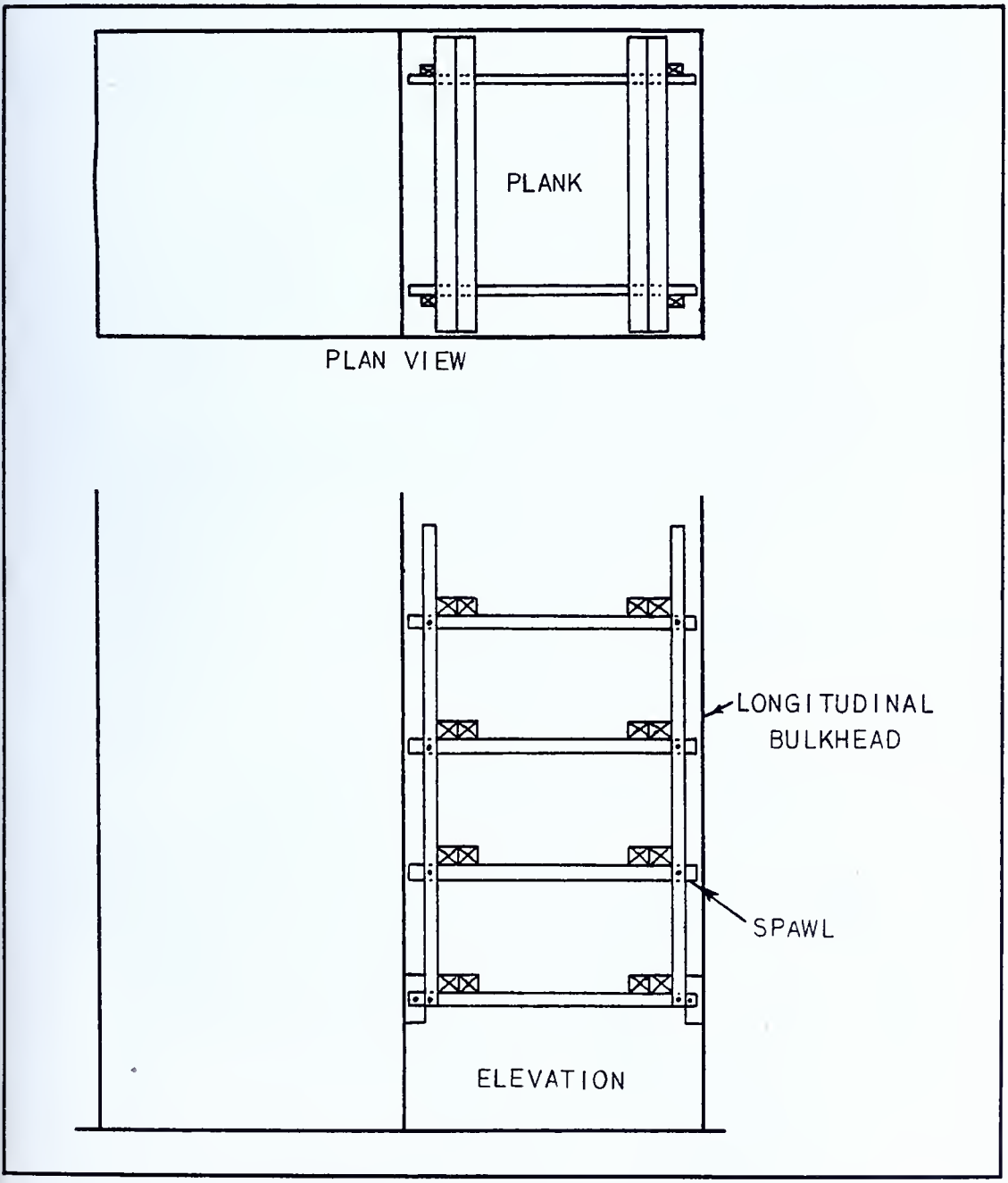


FIG. 127 — *Clips and Spawls Supporting Planks*

3. Bolt 3″ x 5″ spawls to the clips as shown in Fig. 127.

4. Bolt four uprights to the spawls, 6″ away from the longitudinal bulkhead.

   This staging must not be too close to the bulkheads. Clearance must be left to facilitate painting the locker. The painting is done by hand.

5. Bolt spawls on the uprights at each flight height. See Fig. 127.

   These spawls should be slightly shorter than the distance between longitudinal bulkheads. This prevents the staging's swinging transversely.

6. Cut the planks.

   The planks should be cut approximately 2″ shorter than the length of the chain locker.

7. Lay two planks across the spawls on each flight.

8. Fasten the planks with drop bolts.

   Only the top flight of planks needs to be secured with drop bolts as shown in Fig. 126.

QUESTIONS

1. **How is the staging held in position? Explain.**
2. **How are the heights of the staging flights determined?**
3. **Why must we allow clearance between uprights and the shell?**
4. **Explain the use of drop bolts.**

JOB SHEET NO. 24
STAGING THE FOREPEAK

General Information

Two methods of support are used in staging the forepeak. Cross members of the top flight are supported by stringers; all other flights of staging are supported by spawls which are attached to frames.

Tools and Materials

1. Rule
2. Saw
3. Brace and bit
4. Wrench
5. Bolts

Other Mechanic Needed: Burner.

Procedure For Staging the Top Flight of the Forepeak

1. Measure the lengths of the cross planks. (Measure the job). Measure the lengths of the cross planks at the positions shown in Fig. 128 "a". These are placed approximately four feet apart.
2. Cut the cross planks.
3. Place the cross planks on the top stringers.
4. Place top planking at right angles to the cross planks. These run in a fore-and-aft direction.

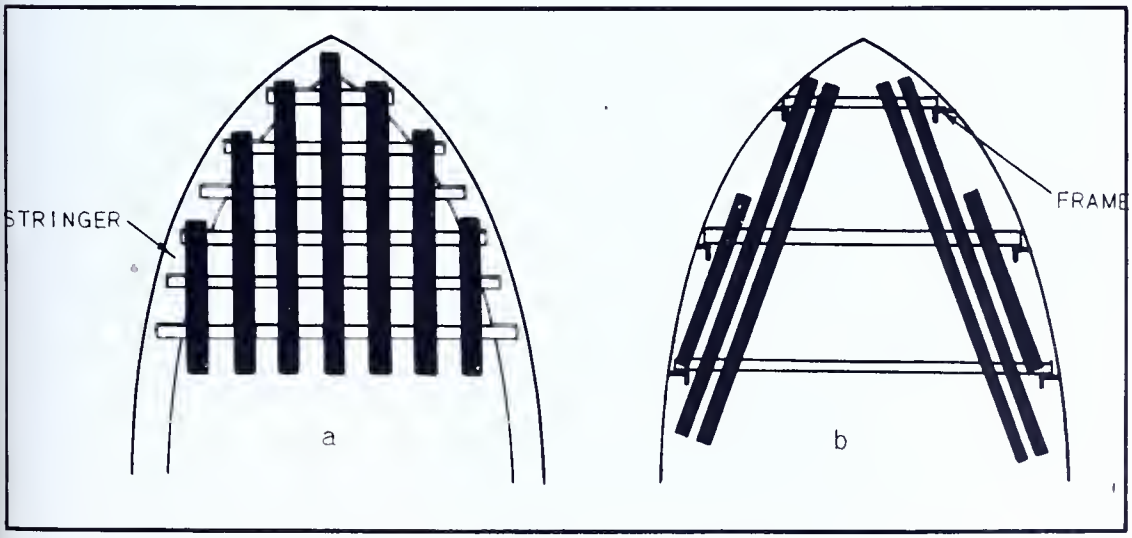


Fig. 128 — *Forepeak Staging*

Procedure for Staging the Lower Flights of the Forepeak

1. Measure the length of spawls.

   Three spawls will usually be sufficient. This depends entirely on the number of frames.

2. Cut spawls to length.

3. Attach spawls to frames.

   The burner cuts holes through the frames so that the spawls can be bolted directly to the frame.

4. Plank the spawls as shown in Fig. 128 "b".

Procedure for Removing the Forepeak Staging

Because of the small opening through which the planks must be passed, the staging in the forepeak must be cut into short pieces before it can be removed. Since the hoist cannot be used, planks are pulled out by hand or with rope and pulley.

A. Cut planks into short lengths, approximately four feet long.

B. Pass planks through manhole by hand or with rope and pulley.

C. Remove the staging in bosun store, after peak, stearing flat, and water ballast tanks.

QUESTIONS

1. **How are spawls attached to the frames in this staging assembly?**
2. **What mechanic burns holes in frames and stiffeners for bolting supporting members?**
3. **What is the procedure for removing forepeak staging?**

JOB SHEET NO. 25
STAGING THE KING-POST

General Information

The king-post staging, as described in this job sheet, has numerous advantages over the old method of assembling the staging, piece by piece in the air. The staging is cut and assembled on the ground and is simply lifted into position by the crane. Bolts hooked to the king-post ladder hold the staging in position. When the work on the post is complete, the end guardrail is removed, and the entire staging is lifted away.

The operation of placing drop bolts is an important safety factor. Failing to place these bolts will permit the cross planks to slide from the staging frame. Falling planks are dangerous to workers on the staging and to the workers on the deck below.

Special Safety Precaution

Give particular attention to the placing of drop bolts in the cross planks.

Tools and Materials

1. Saw
2. Brace and bit
3. Wrench
4. Square
5. Bolts
6. Clips
7. Hook Bolts

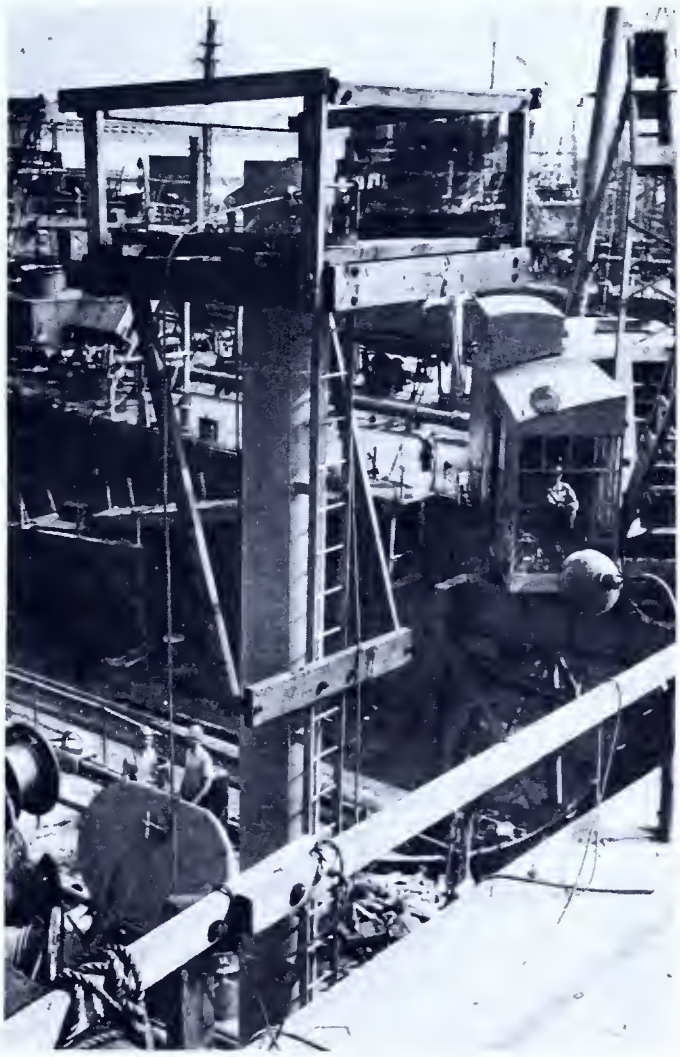


Fig. 129 — *Single King-Post Stage*

PROCEDURE

1. Cut 3″ x 10″ planks for frame work.

   2 pieces — 3″ x 10″ x 8′-6″.

   2 pieces — 3″ x 10″ x 7′-0″.

2. Secure four large clips.

   These clips must be larger than the usual clip.

   A 6″ x 6″ x ½″ x 10″ long is a good size.

3. Assemble frame work with clips and bolts according to the dimensions given in the top view of Fig. 130.

   These four planks are assembled with 6″ x 6″ x ½″ x 10″ clips and bolts. The large clips are used so that the bolts in the cross members need not be placed near the end of the plank. This strengthens the staging as a whole by preventing the bolts in the cross members from pulling out through the holes. The top view of Fig. 130 shows the position of the clips.

4. Place the guardrail.

   Bolt four legs to the frame. The side rails are bolted directly to the top of the legs; the end rails are fastened to the legs with clips and bolts.

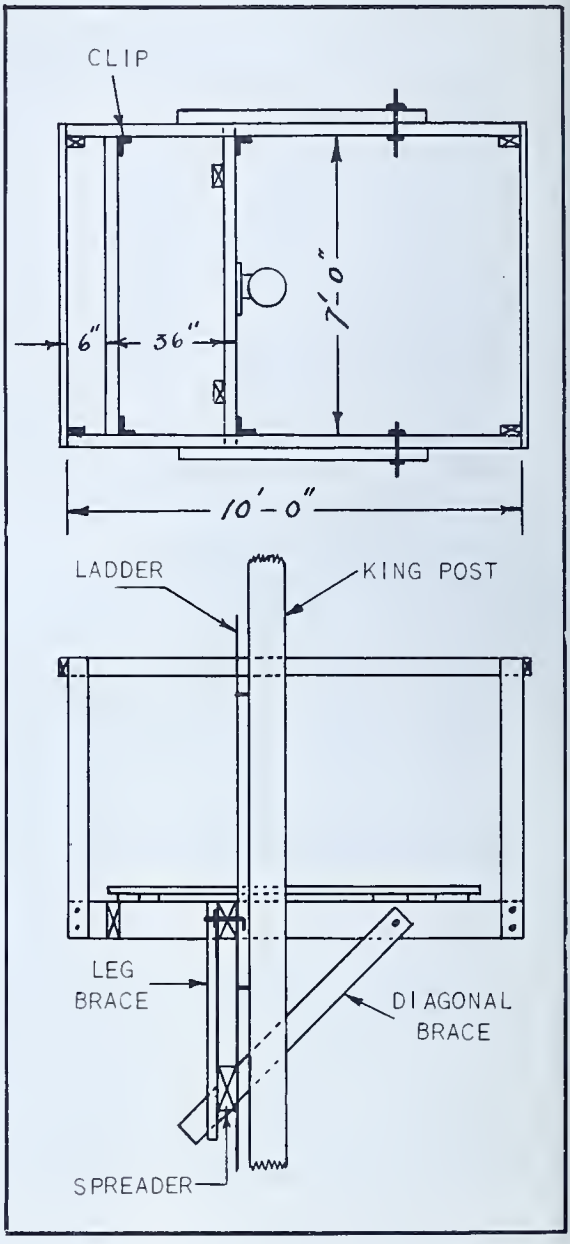


FIG. 130 — *King-Post Staging*

5. Cut the following brace members:

   A. 1 piece, 3″ x 10″ x 7′-6″.

   B. 2 pieces, 3″ x 5″ x 10′-0″.

   C. 2 pieces, 3″ x 5″ x 8′-0″.

6. Attach the diagonal braces.

   NOTE: One brace is attached to each side of the frame and with one bolt only. Locate approximately 2 feet from the end of the frame.

FIG. 131 — *Twin King-Post Staging*

7. Place the 3″ x 10″ spreader between the diagonal braces with clips. See Fig. 130.

8. Attach the two vertical braces.

   NOTE: These legs are bolted to the center cross member of the frame and to the 3″ x 10″ spreader. One bolt in each joint is sufficient.

9. Drill holes for hook bolts.

   NOTE: The staging is held in position with hook bolts. The hook bolt holes are elongated so that the bolts may be moved to fit any size of king-post ladder. See Fig. 132.

10. Measure and cut the planks.

11. Erect the staging with a crane.

    NOTE: The crane drops the staging assembly over the king post at the proper working height. The stage builder then fastens the hook bolts to the ladder before the crane is released.

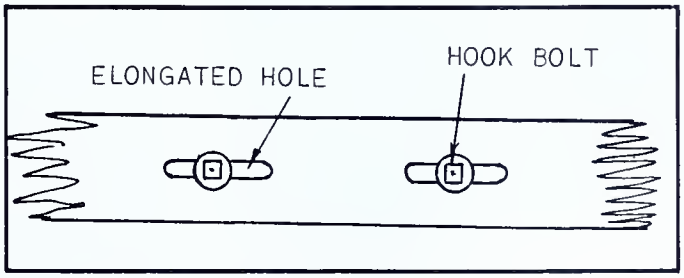


FIG. 132 — *Elongated Hook Bolt Holes*

12. Plank the staging.

13. Fasten the cross planks with drop bolts.
(Drop bolts prevent the cross planks from sliding. See Fig. 126).

Procedure for Removing King-Post Staging

1. Remove the guardrail from the forward end.

2. Remove the planking from the staging.

3. Attach the crane to the staging.

4. Remove all hook bolts.

5. Lift staging from the king-post.
Move the staging to some convenient place for storage.

QUESTIONS

1. **What is the advantage of this king-post staging assembly?**
2. **Explain the purpose of the wide clips in this assembly.**
3. **How is the staging assembly secured to the king-post?**
4. **How much of the king-post staging can be assembled on the ground?**
5. **How is the king-post staging erected?**
6. **Why are the hook bolt holes elongated?**
7. **Draw a sketch on the blackboard to show how drop bolts are used.**
8. **Why are drop bolts necessary on the cross planks?**
9. **How is the king-post staging removed?**

JOB SHEET NO. 26
ESTABLISHING DRAFT MARKS

General Information

Draft marks which are placed on the ship shell according to the blueprint specifications are cut in by the chipper. The chipper follows the outlines which have been previously painted on or laid out by the stage builder.

Draft marks are numbers on the fore, aft, and midship sections of the ship to show the depth of the ship in the water. See Fig. 133. The draft marks are rather difficult to place, since the marks are measured as vertical distances rather than straight surface measurements on the shell. These markings are important; they must be placed accurately, and they must be checked by the insurance inspector and the inspector representing the ship owner. The inspector for the insurance company is interested in the structural safety of the ship; it is his duty to check draft marks so that the ship is not overloaded under normal conditions. This condition would exist if the marks were placed too high. The inspector for the ship owner is interested in having draft marks accurate so that the maximum carrying load is attained. If draft marks were placed too low, the actual maximum load of the ship would never be possible.

The usual order of placing draft marks is amidships, after, and forward sections. This order is followed because the hull sections are completed in that particular order. Each set of marks is placed independently of the other two.

FIG. 133 — *Draft Marks Painted on Bow*

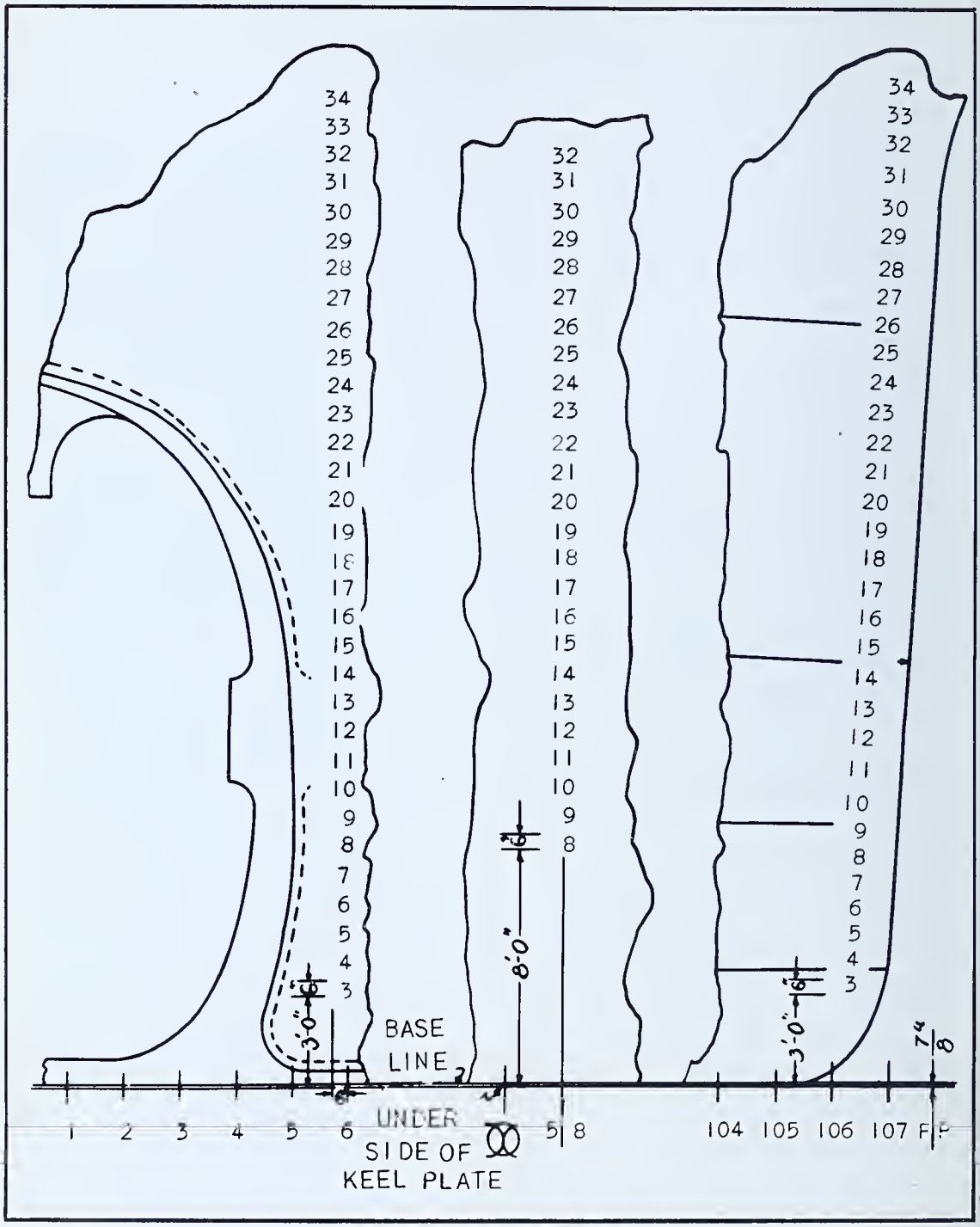


Fig. 134 — *Draft Marks*

The two men who do the actual measuring operation are 25 to 30 feet apart when establishing the maximum marks. Surrounding noises make it practically impossible to speak from one end of the tape to the other. The following set of signals materially helps working the tape line:

1. Mark correct — Nod the head.
2. Line down — Pull lightly on the line.
3. Line up — Shake the line.

The procedure for establishing draft marks as described in this job sheet is the procedure which is followed by the draft-mark inspectors.

In addition to draft marks, other markings called load lines are placed at certain points on the outside of the shell of the ship. The explanation of these markings is given on the next job sheet.

Tools and Materials

1. Saw
2. Hatchet
3. Tape
4. Square
5. Level
6. Rule
7. Scriber and soapstone
8. Declivity board
9. Nails

Other Mechanics Needed: Inspectors and painters.

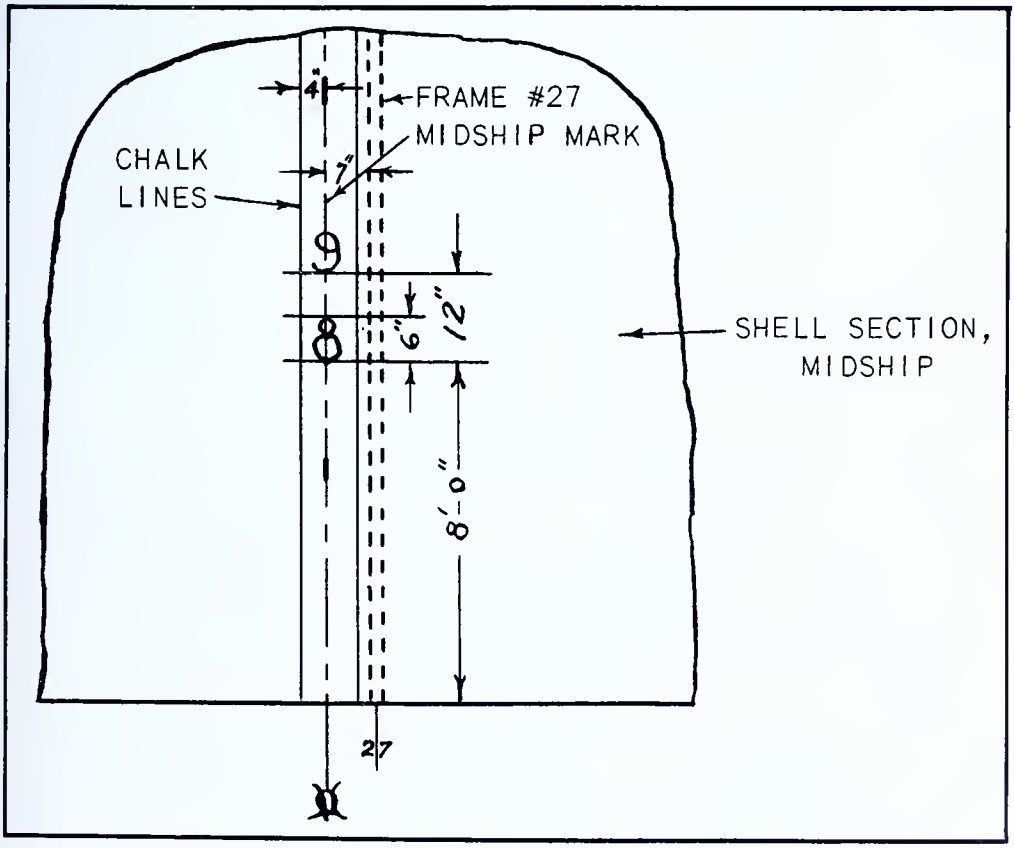


Fig. 135 — *Location of Guidelines for Midship Draft Marks*

PROCEDURE (For establishing midship draft marks).

1. Obtain a sketch from the office showing the location of the forward, midship, and after end draft marks.

   The sketch shows the center line location of the draft marks. This mark will be specified as a certain longitudinal distance from a specific frame line. See Fig 135.

2. From the sketch, locate the midship mark. See Fig. 135.

   The midship mark for draft marks will be located a specific longitudinal distance from a specific frame line. This measurement and frame line will be specified on the drawing.

3. Mark the midship point at the top and bottom of the side shell.

4. Measure four inches on each side of the midship mark. See Fig. 135.

5. Snap a chalk line through these points. See Fig. 135.

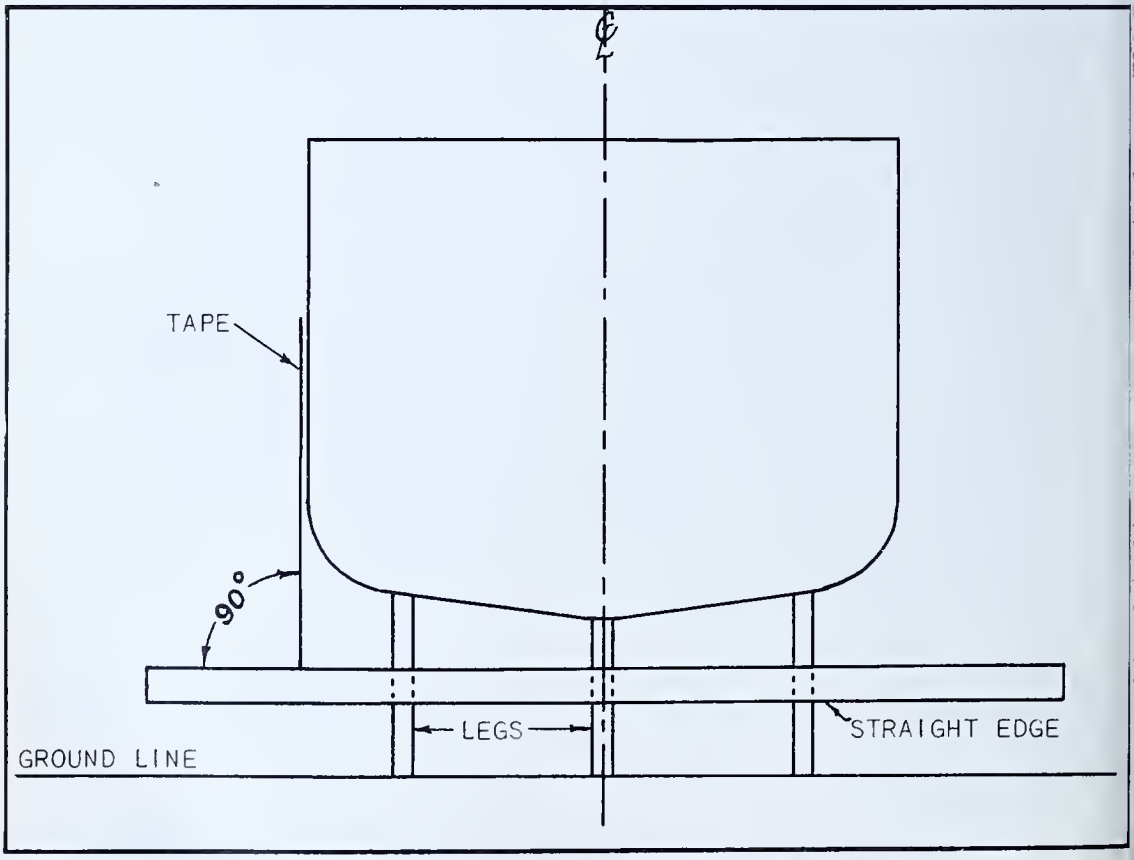


FIG. 136 — *Measuring Midship Draft Marks*

6. One foot below the center of the keel, place a straightedge that will extend several feet beyond the side shell.
   Wedge several legs between the shipway and the bottom shell; nail the straightedge to these legs. Fig. 136 shows the straightedge and legs in position.
7. Extend a tape from the straightedge to a point above the top draft mark.
8. On one of the chalk lines measure and mark intervals of 6″.
   A. Determine from the drawing the height of the top marking.
   B. The tape must be held at right angles to the straightedge as shown in Fig. 136.
   C. Use a scriber to mark the spaces. A soapstone line is too heavy for accuracy.
   D. Figure 137 shows these markings.
9. Draw a line through the established points.
   Level from each established point and scribe a horizontal line between the two vertical chalk lines. A declivity board must be used with the level.
10. Have the inspectors check the midship draft marks.
    The American Bureau of Shipping and the ship owner inspectors must both inspect and check the marks.
11. After the marks have passed inspection, take down the straightedge.
12. Notify the sign painter.
    If the sign painter is not available immediately, mark the lines with a center punch.

PROCEDURE (For Establishing the After-End Draft Marks).

1. Establish the vertical guidelines for the draft marks.
   Follow the same procedure as listed in the procedure for establishing midship draft marks. (Steps 1-5).
2. Place two 18-foot straightedges at right angles to the center of the keel and in line with the two chalk lines, as shown in Fig. 138-B.
   Fasten the straightedges in position with legs and braces nailed to the shipways.
3. Measure 6″ intervals along each chalk line.
   Remember that the tape must be held at right angles to the straightedge in order to have an accurate measurement. See Fig. 138-A.
4. Draw a line through the established points.
5. Have the inspectors check the marks.
6. After the marks have been inspected, take down the straightedges.
7. Notify the sign painter.

PROCEDURE (For Establishing Forward-End Draft Marks).

1. Establish the guidelines.

The draft marks at the forward end of the ship are not in a vertical line or parallel to the frame lines. Instead, they run parallel with the rake of the bow.

(a) Find the distance from the center of the draft marks to the end rake of the bow.

(b) Measure this distance from the edge of the bow near the bottom of the keel and approximately 25 feet above this point.

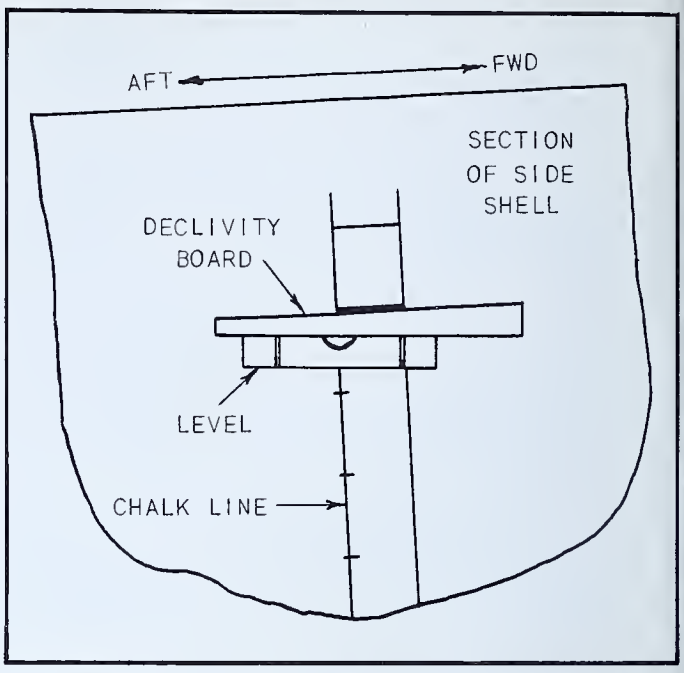


FIG. 137 — *Scribing Midship Draft Marks*

(c) Snap a chalk line through these points.

(d) Snap a second line 8″ aft of the first line.

2. On a keel block, approximately 20 feet from the forward end of the ship, nail a straightedge "a" as shown in Fig. 139-B. This straightedge is placed transversely, level, and one foot below the center of the keel.

3. From straightedge "a" establish and nail the straightedge "b" on a keel block near the forward end of the ship.

Level the straightedge transversely and also on declivity with edge "a", Fig. 139-B.

4. Locate and place straightedge "c", Fig. 139-B.

Approximately 8 feet forward from "b" nail legs to the shipway. The legs act as supporting members for straightedge "c" which is on declivity line with "a" and "b".

5. Lay straight edge longitudinally from "b" to "c".

6. Measure intervals of 6″ on each chalk line until the top mark is reached.

The end of the line must be held even with the bottom edge of the straightedge. Here again the tape must be held at right angles to the straightedge and parallel to the center line of the ship. Plumbness to the center line of the ship is usually

sighted by the man working the tape from the top. See Fig. 139-A. The straightedge "d" must be moved in a transverse direction with the tape as each marking is measured.

7. Have the lines inspected.
8. After inspection, take down straightedges.
9. Notify the sign painter.

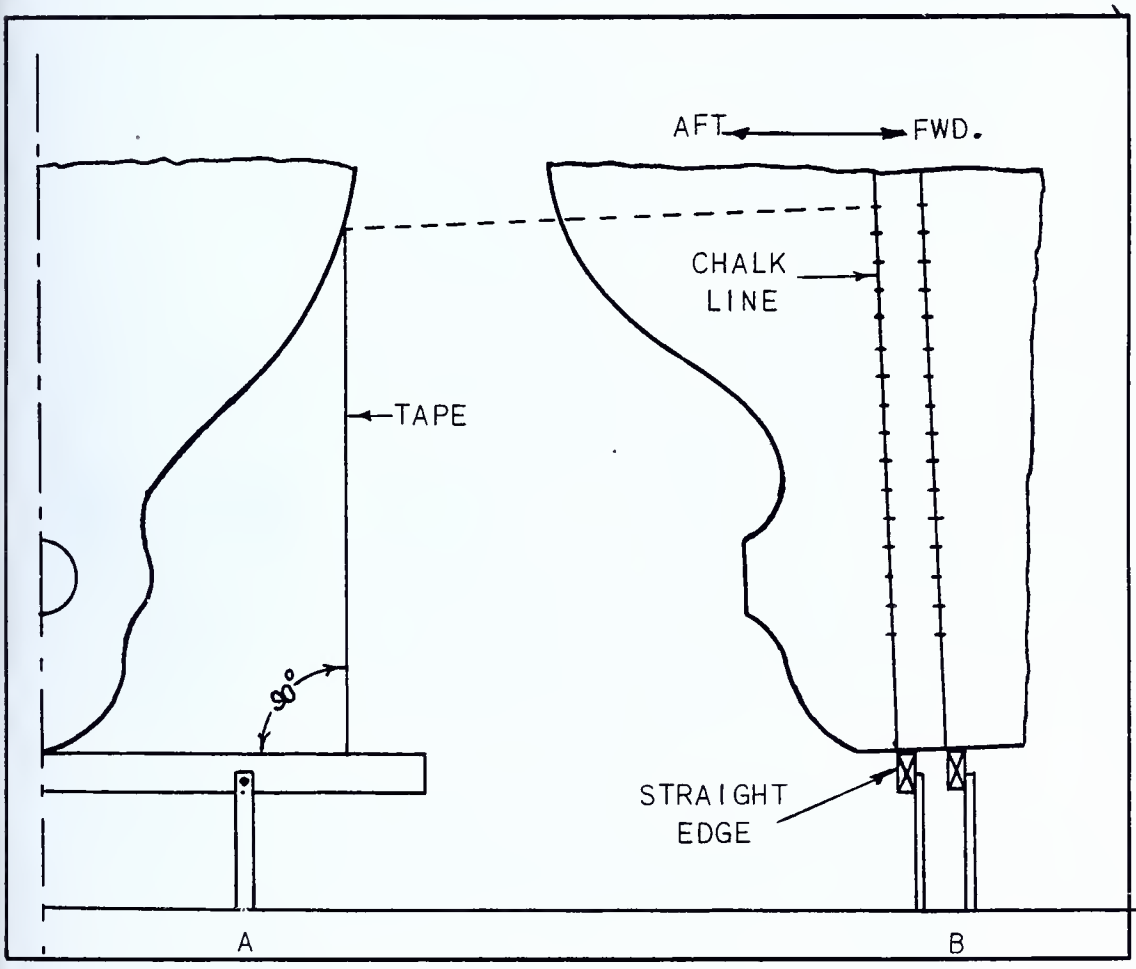


FIG. 138 — *Establishing Draft Marks on the After End*

DRY DOCK PROCEDURE

The procedure followed when putting draft marks on a ship when the ship is on dry dock, is similar to the method used on the shipways. Care must be taken in erecting the targets on the keel blocks. A dry dock is similar to a ship, for it floats free, and any wake from a ship passing by causes the dry dock to have a slight movement. This slight movement may effect the leveling of the targets, and if the targets are not true, a straight, true line cannot be carried

parallel to the bottom of the ship. This true line must be carried to the bow or stern as a base to work from when laying out draft marks. Check the true line several times before beginning the actual laying out of the draft marks. A metric conversion table (see Table VII, page 321) is used for laying out draft marks when the Metric System is used.

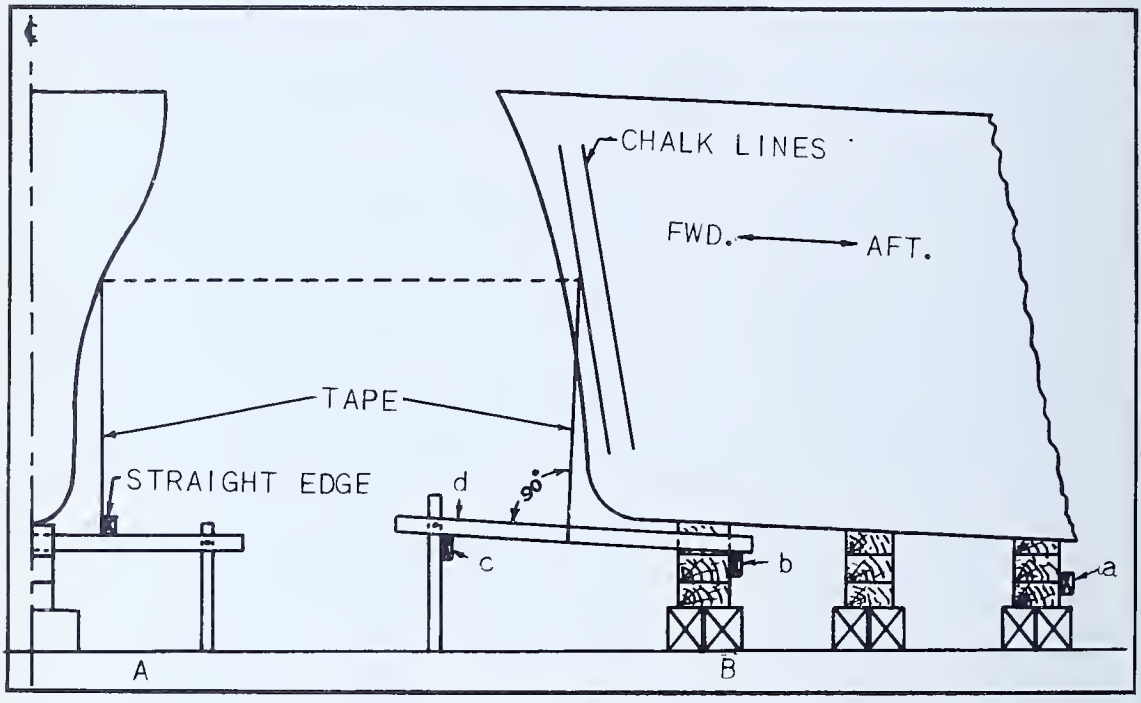


FIG. 139 — *Placing Draft Marks on Forward End*

QUESTIONS

1. **On what sections of the ship are draft marks located?**
2. **Why is it important that draft marks be placed accurately?**
3. **Who inspects draft marks before they are placed permanently?**
4. **What is the usual order of placing draft marks? Why?**
5. **Why are draft marks necessary on the ship hull?**
6. **Explain how draft marks are located on the midship section.**
7. **Explain the procedure for establishing draft marks on the after end of the ship.**
8. **Why do draft marks on the forward end of the ship run parallel with frame lines?**
9. **Describe the procedure for establishing draft marks on the forward end of the ship.**

JOB SHEET NO. 27
ESTABLISHING THE LOAD LINE

The load line is the line defining the maximum mean draft to which a vessel may be lawfully submerged. The lower limit of the freeboard is determined by regulations applying to the various conditions and seasons.

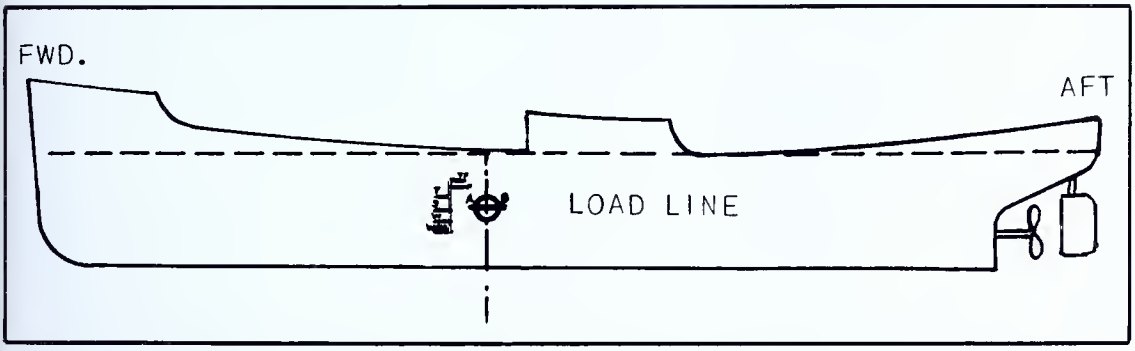


FIG. 140 — *Location of Load Line Markings*

It is the work of the ship carpenter to lay out the necessary lines on the ship shell according to the blueprint specifications. The stage builder has the responsibility of erecting suitable staging on which the mechanics stand to establish the load line and necessary lettering outlines.

After the lines are all laid out, the chipper cuts in between the lines, making a clean groove to follow when "welding in" a bead.

"S" MEANS SUMMER LOAD LINE

The summer load line is indicated by the upper edge of the line which passes through the center of the disk, and also by a line marked "S". Ships are loaded during the summer to this line.

"W" MEANS WINTER LOAD LINE

The winter load line is indicated by the upper edge of a line marked "W". Ships are loaded to this line during the winter.

"W.N.A." MEANS WINTER NORTH ATLANTIC

The Winter-North-Atlantic load line is indicated by the upper edge of a line marked "W.N.A." Ships, when travelling the North Atlantic during the winter, are loaded to this line.

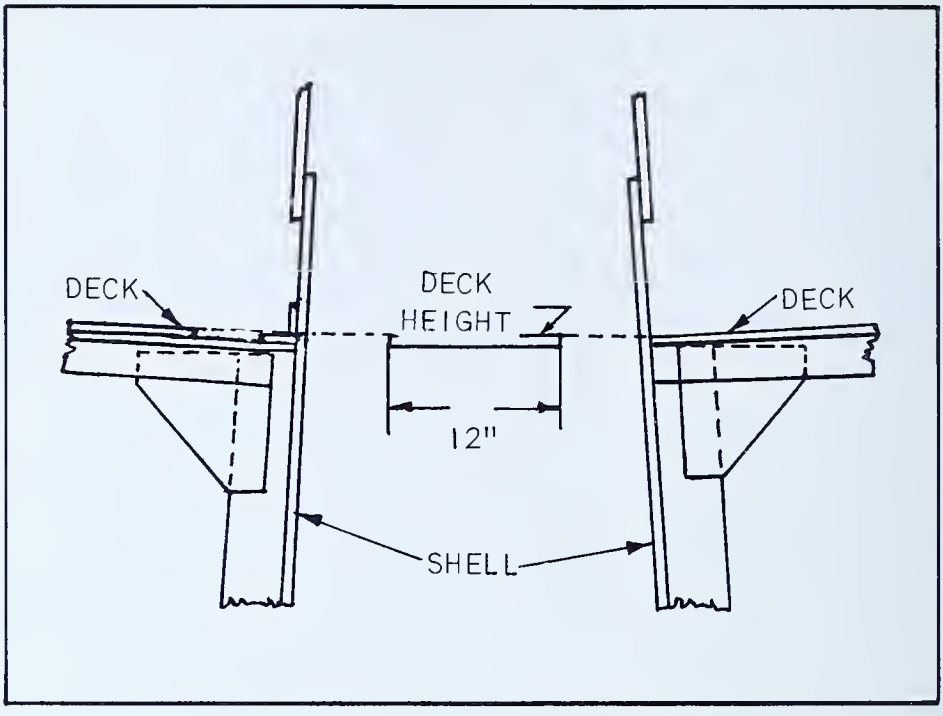


FIG. 141 — *Location of Deck-Height Marking*

"T" MEANS TROPICAL LOAD LINE

The tropical load line is indicated by the upper edge of a line marked "T". Ships, when traveling in tropical waters, are loaded to this line.

"F" MEANS FRESH-WATER LOAD LINE

The fresh-water load line in summer is indicated by the upper edge of a line marked "F". The difference between the fresh-water load line in summer and the summer load line is the allowance to be made for loading in fresh water at the load lines. Ships are loaded to this line when traveling in fresh water.

"T.F." MEANS TROPICAL, FRESH-WATER LOAD LINE

The tropical, fresh-water load line in the summer is indicated by the upper edge of a line marked "T.F." Ships, when traveling in tropical, fresh waters, are loaded to this line.

Where the draft is restricted on a basis of subdivision or stability, and this draft is less than any of the various seasonal drafts permitted by these regulations, the center of the disk must be located on the line of this restricted draft, and it shall be applicable to all zones and seasons. If such a permissible

maximum draft comes between the seasonal markings, the seasonal markings below shall also be added. A fresh-water load line may be marked forward of the disk as provided in this rule.

These lines, which indicate the maximum load line in different circumstances and in different seasons, are to be horizontal lines 9″ in length and 1″

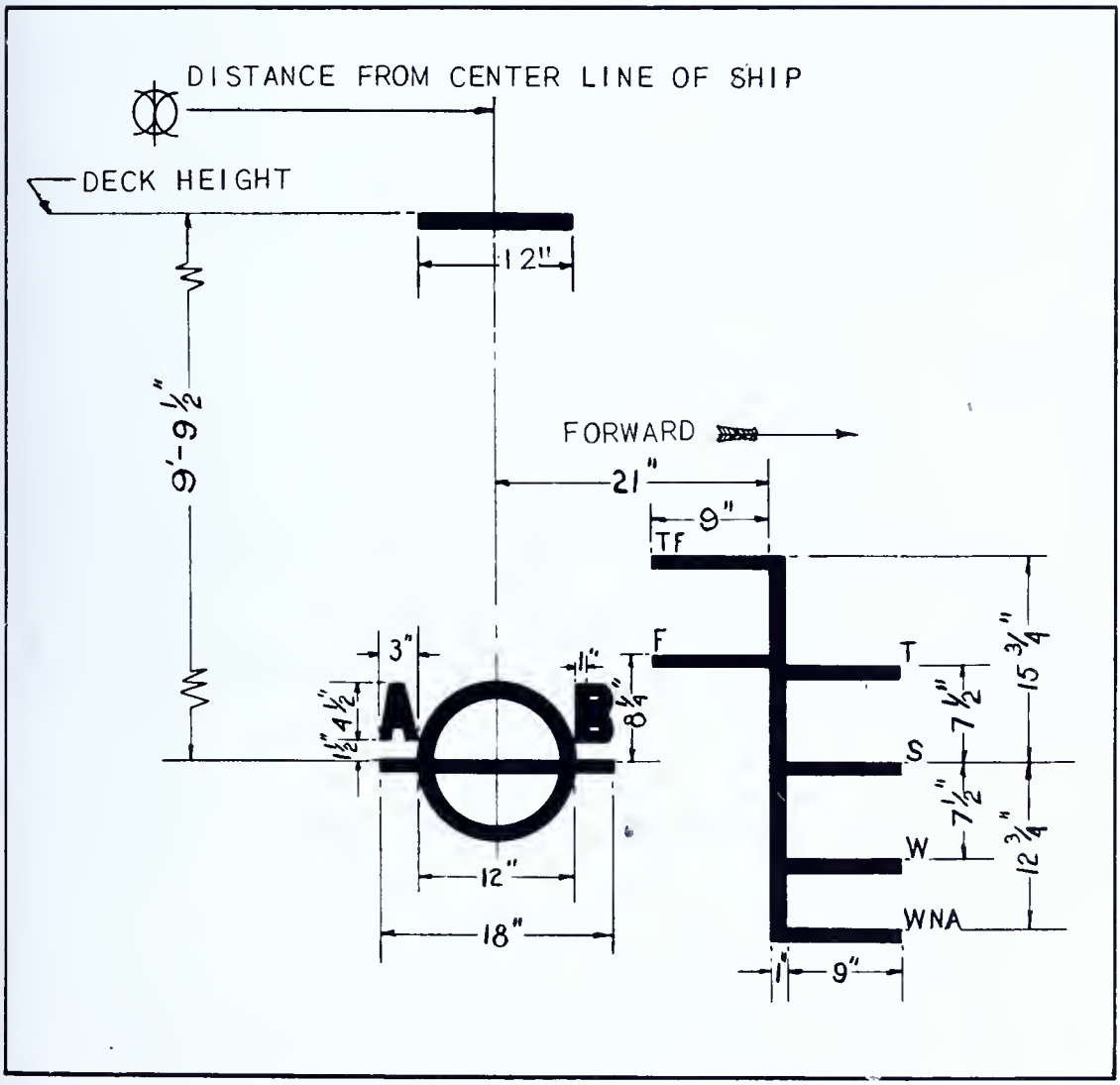


Fig. 142 — *Dimensions for Load Line Markings*

in breadth extending from, and at right angles to, a vertical line marked 21″ forward from the center of the disk. See Fig. 142.

Marks of Authority

The authority by whom the load lines are assigned may be indicated by

letters measuring about 4½" high and 3" wide alongside the disk and above the center line. The authority is marked A-B in Fig. 142.

Detail of Markings

The disk, lines, and letters are to be painted in white or yellow on a dark background, or in black on a light background. They are also to be carefully cut in and a bead is welded in the groove on the sides of steel ships.

Verification of Marks

The load-line certificates are not to be delivered to the ship until a surveyor of the assigning authority has certified that the marks are correctly and permanently indicated on the side of the ship.

There is also another set of load-line markings for carrying lumber. They are called:

Timber Load Line

A timber load line is a special load line to be used only when the ship is carrying a timber deck cargo.

The load lines are placed on both sides of the ship at the center of the ship's length. All measurements are taken from a sketch or certificate given by the local surveyor.

Laying Out the Load Lines

Procedure

1. Transfer the deck line, Fig. 141, to the outside of the shell.
2. Measure from this line down to the disk center, Fig. 142, as shown.
   The disk shall be located vertically down from the deck bar.
3. Center punch the center location of the disk.
4. With the center punch mark as a center, scribe the required circles as shown in Fig. 142
5. Scribe a vertical centerline a measured distance from the ship centerline, as shown in Fig. 142,

6. With the steel scriber lay off the load line markings at the right of the 12″ disk, according to the dimensions shown in Fig. 142.

7. Have the painter "paint in" between the lines.

   The painting makes the lines easy to inspect.

8. Have the location of the lines inspected.

9. If the work is approved, have the chipper cut a groove along the lines with a chipping gun.

10. Have the welder weld a bead all along the grooves.

    The welding makes the lines stand out permanently from the shell, and they can be more easily seen when the ship is old and rusted.

JOB SHEET NO. 28
ERECTING STANCHIONS

General Information

Stanchions placed by the stage builder or shipwright are not main structural stanchions; they are light supplementary supports for decks that have heavy objects placed overhead. They are usually only 8 or 10 feet long so that they can be handled without the use of a crane or hoist.

In some instances shipwrights work with the joiners in erecting stanchions. The reason for having the joiners is that some stanchions need to be moved slightly from the original blueprint measurements to accommodate the placing of panels.

When several stanchions are placed in one straight line, the two end stanchions are placed and plumbed, and the intermediate stanchions are set to a line.

Stanchions are usually found at the following locations:

1. Under forecastle deck.
2. In bosun stores.
3. In the bridge deck, midship.
4. On navigating bridge.
5. In boat deck.
6. In steering gear flat.
7. In the after quarters.

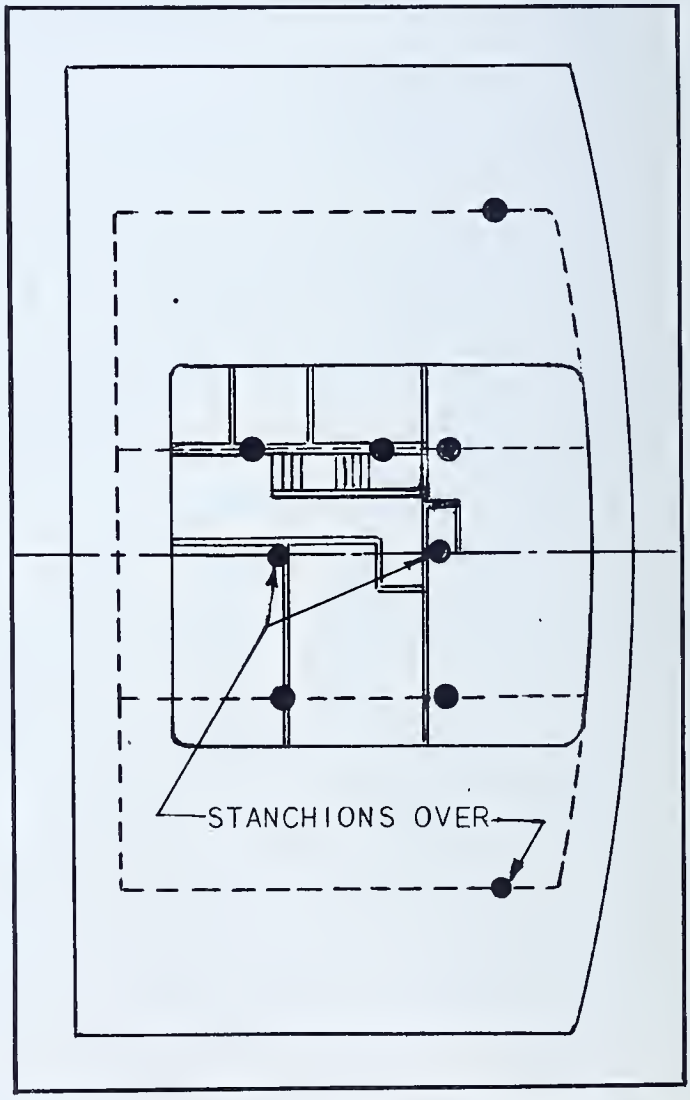


Fig. 143 — *Plan View of Upper Bridge Deck Stanchion Locations*

SPECIAL SAFETY PRECAUTION

Exercise care in handling and carrying the heavy pillars.

Tools and Materials

1. Level
2. Declivity board
3. Chalk line
4. Soapstone
5. Maul
6. Hammer
7. Center punch
8. 6″ C-clamp
9. Rule

OTHER MECHANICS NEEDED: Welder, joiner, and burner

PROCEDURE

1. Secure a blueprint from the office.
   The print will show the center line location of each stanchion from a particular frame.
2. Determine the number and kinds of stanchions needed.
3. Secure the stanchions from the steel rack.
4. Mark the approximate length of each stanchion.
5. Have the burner cut the stanchions.
6. Locate the stanchions at a convenient place on the ship.
7. Find the location of each specific stanchion from the blueprint.
8. Mark the location of the stanchion with soapstone.
   The position of stanchions is determined from the frames and from the centerline markings. The fore-and-aft location of the stanchion will be given as a certain

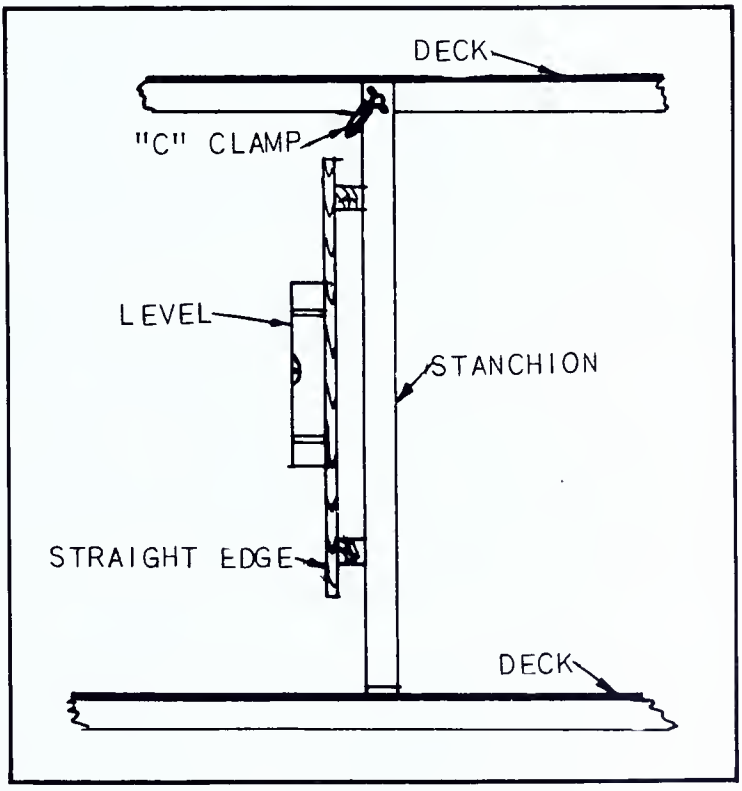


FIG. 144 — *Plumbing a Stanchion Transversely*

distance forward from a given frame; the location of the stanchion transversely will be a given distance from the center line of the ship. The intersection of these two measurements establishes the center of the stanchion.

9. Center punch this marking so that the location will not be lost.

10. With a measuring stick, find the exact length of the stanchion.

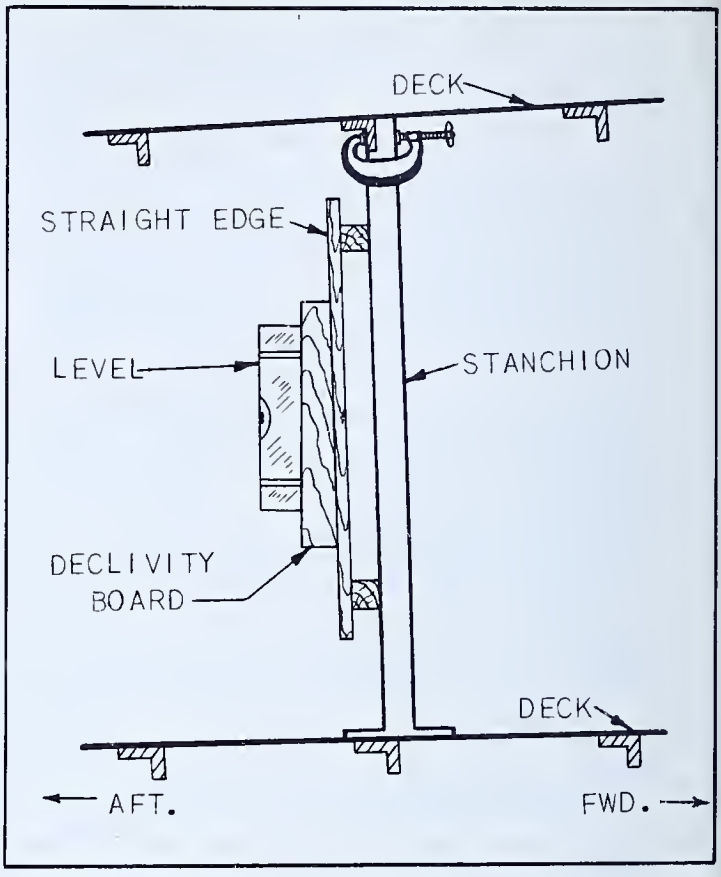


FIG. 145 — *Plumbing a Stanchion Fore-and-Aft*

A measuring stick consists of two straight, light pieces of wood which are placed between the two fixed points, or extremities, of the stanchion. A small clamp is placed to hold the two sticks together. The stick can then be used to mark the exact length of the stanchion.

11. Have the burner cut the stanchion to the exact length.

12. Place the stanchion in position.

13. Plumb the stanchion transversely as shown in Fig. 144.

This procedure in plumbing is used because of the irregularities in most stanchions. The small blocks tacked to the straightedge must be the same thickness.

14. Plumb the stanchion fore and aft, using a declivity board. See Fig. 145.

15. Wherever possible, clamp the stanchion in this position with a C-clamp.

16. When the stanchion is plumb, have the welder tack it.

QUESTIONS

1. Where are stanchions usually located?
2. Why are stanchions not always located at the exact blueprint locations?
3. How are stanchions located?
4. Why should stanchion locations be center-punched?
5. How is the exact length of the stanchion determined and marked on the stock?
6. Describe the procedure employed in plumbing a stanchion.

JOB SHEET NO. 29
ESTABLISHING PAINT LINES

General Information

The paint line is a noticeable line on all ships, because the color of paint usually changes at this point. The point of intersection of each frame line with the paint line is found on a tabulated chart obtained from the mold loft. These points are transferred to the ship by actual measurement. See Fig. 146.

Tools and Materials

1. Rule
2. Chalk
3. Hammer
4. Center punch
5. Chalk line

Other Mechanic Needed: Welder.

Procedure

1. From the mold loft get a table of measurements for locating the paint lines.

   The mold loft has the ship laid out in full scale. It is a simple matter for the mold loft to draw the paint lines on the full-scale layout. The paint line runs longitudinally along the various plates, across the frame lines, and at a certain distance from the top or bottom sight edge of each plate stroke. The following measurements are taken from the mold-loft layout: the frame number, the plate letter through which the point passes, and the distance from the paint line to the sight edge of the plate. The table gives these three facts for every frame. See Fig. 146.

2. Lay off, on the port side of the ship, the points through which the load line will pass.

   Start the layout at the midship frame and work in both directions. Mark each frame at the point specified by the loft chart.

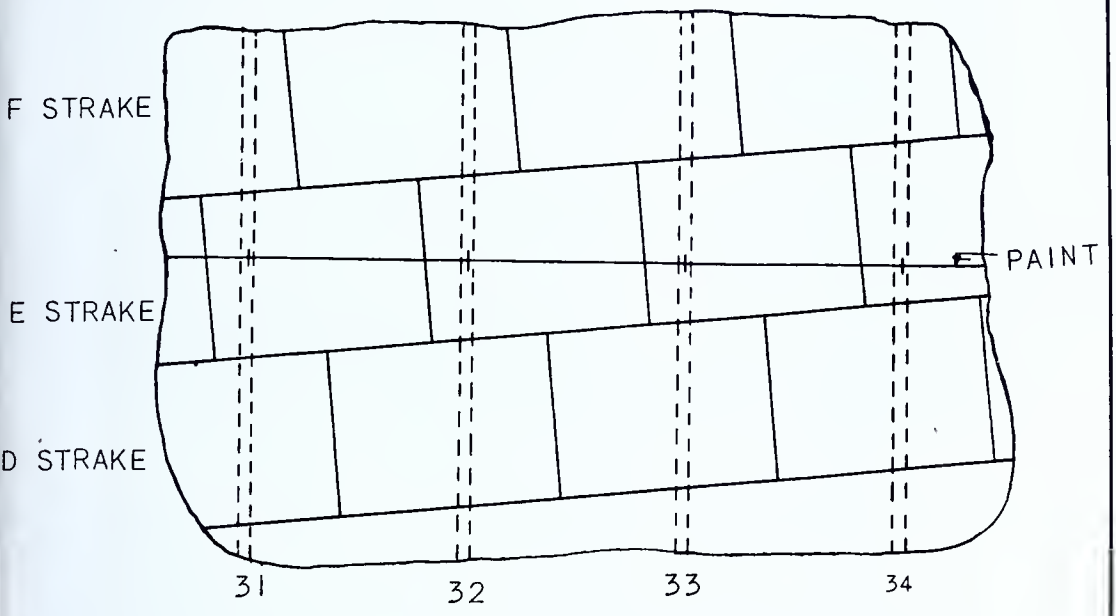
3. Strike a chalk line through the established points.

4. Sight the chalk line for straightness.

   Irregularities in the line can easily and quickly be located by sighting. Rub out the lines at abrupt departures from straightness, and re-line such short spans.

5. Center-punch the line at intervals of 8″.

   A chalk line is not a permanent line; it may be rubbed off by workmen, or it may be washed off. The chalk line should be center-punched as soon as it is struck, so that a permanent mark is established.



	BELOW UPPER E			ABOVE LOWER E		
FRAME	FT.	IN.	1" 8	FT.	IN.	1" 8
31	1	2	3			
32	1	3	1			
33				3	1	5
34				2	1	3

FIG. 146 — *Locating the Paint Line*

6. Mark intervals of 8 feet on the line for a welder's mark.

After a permanent line has been established, mark every 8 feet. The welder runs a 3″ straight bead at each of these points. This bead acts as a permanent line marking.

7. Follow the same procedure on the starboard side of the ship.

QUESTIONS

1. What is a "sight edge"?
2. What is a load line?
3. How is the paint line marked permanently?
4. Explain how the points through which the line will pass are established on the ship.
5. Explain how draft marks are located on the midship section.
6. How can one (looking at a ship from a distance) detect the paint line?

JOB SHEET NO. 30
REMOVING OUTSIDE STAGING BEFORE LAUNCHING

General Information

When the ship has been painted, the stage builders remove the outside staging in preparation for launching. Since the purpose of removing outside staging is to provide clearance for the ship as it slides down the ways, each section of staging is treated differently.

The midship section of staging is not actually removed; it is simply folded back to provide proper clearance.

The after-end staging must be removed entirely, since the ship skids into the water at this end of the way.

The forward end needs only to be partly cleared to accommodate the launching stand and to provide clearance for cables, which attach from the deck of the ship to the cribbing supporting the ship on the launch way.

Several general rules will apply to this job of removing outside staging:

1. When stripping staging, work one flight at a time, starting from the top.
2. Remove the bottom flight of staging entirely to facilitate "ramming" the ship for launching.
3. Tie securely into position any struts or towers which are moved to the side.

Explanation of Terms

1. *Folding back staging* means to double the planks, slide them against the tower, and push back the spawls.
2. *Stripping staging* means to remove guardrails, planking and legs, and to push back the spawls.

Special Safety Precautions

1. Exercise caution while climbing.
2. Be careful not to drop materials on workmen below.
3. Signal to men who are working below as well as to fellow workmen who are helping to lower planks.

Tools and Materials

1. Rope
2. Wrench
3. Saw

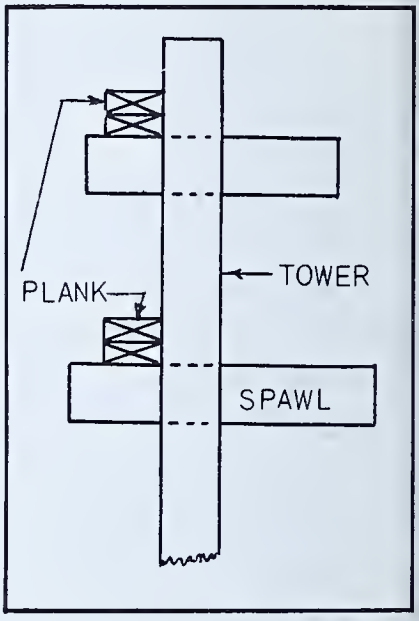


Fig. 147 — *Planks rolled back against tower*

Procedure: (For Removing Outside Staging, Midship Section).

1. Consider all staging towers not having struts as in the midship section.
2. Double the planking, as shown in Fig. 147.
3. Push the double planking against the towers.
4. Push back the spawls to support the planks.
5. Begin this procedure on the top flight. Complete each flight before going on to the next one.
6. Remove the entire bottom flight of staging.
   Remove the planks, and push back the spawls as far as possible.

Procedure (For Removing Staging from the After End).

1. Remove planks from the after-end staging.
   This procedure is usually begun on the top flight, and three sections are usually stripped together.
   A. Double the top planks of the center section, as shown in Fig. 148-2. The purpose of these planks is to support the rope which is used in lowering the planks. When the three sections of staging have been stripped, these two planks are removed with a crane.
   B. Remove guardrails and legs, and lower them with a rope.
   C. Lower the planks of the top flight. See Fig. 148.
      (1) Remove one plank at a time from the spawls to the flight below and into the position shown in Fig. 148.
      (2) Fasten the rope around the planks with a timber hitch or clove hitch and half hitch.
      (3) Signal the other men on the staging and the men working below.
      (4) Push the end of the plank off the staging. See the man on the left in Fig. 148-2.
      (5) Lower the plank to the ground.

D. Lower the planking on succeeding flights.

The procedure for lowering succeeding flights is slightly different. Lower planks in section 2 first; then the side planks from sections 1 and 3, Fig. 148.

E. Push the spawls back into the towers.

F. Repeat the above operations until the stripping is complete.

2. Remove the top rope supporting planks, section 2, Fig. 148.

When all staging planks have been removed, the planks which were used as a support for the rope are removed with the crane.

3. Lift out the struts with the crane.

The struts are removed and placed against the crane column or in some other convenient place on the way. If struts remain in an upright position, they must be tied so that they cannot fall and cause injury.

4. Lift out the stern towers.

The stern towers are lifted out with the crane and placed securely at some convenient place on the way.

5. Remove the piles of planks to a convenient, out-of-the-way location on the way.

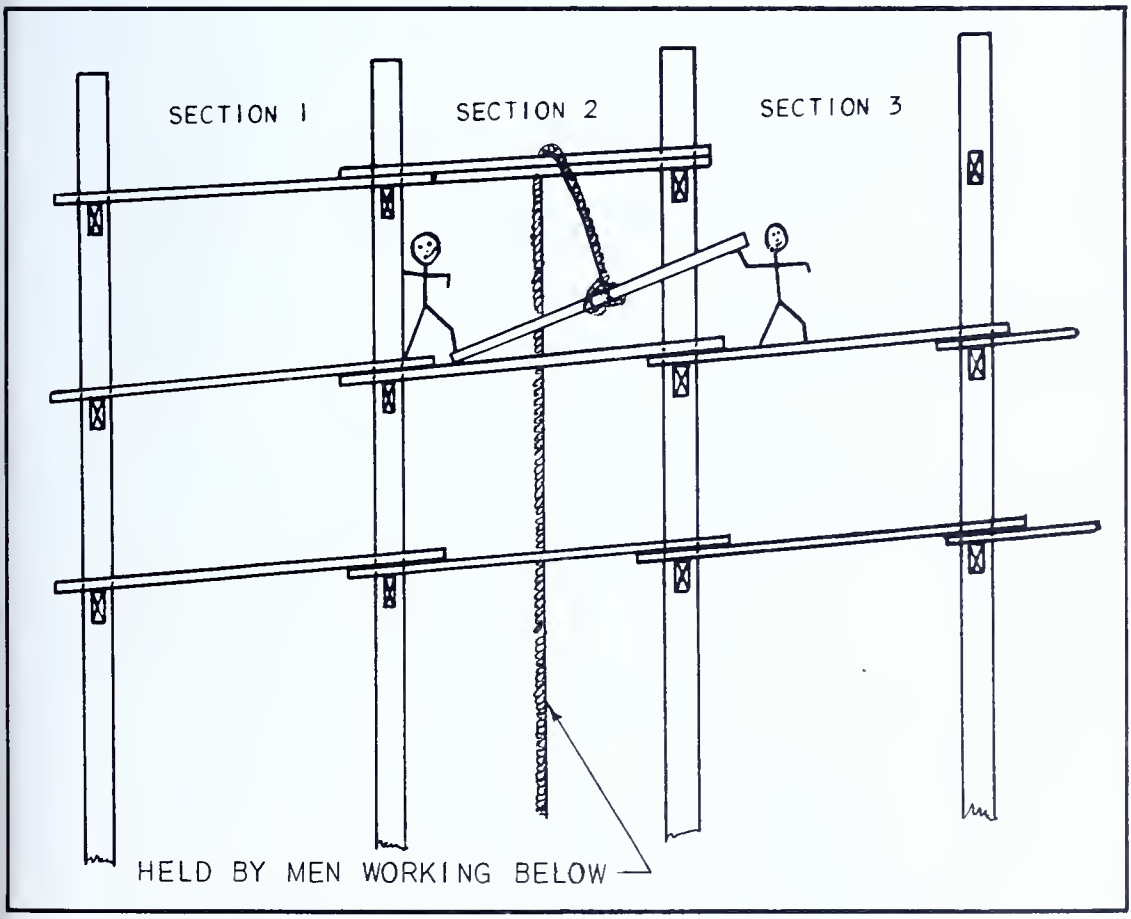


FIG. 148 — *Stripping Outer Staging*

PROCEDURE (For Removing Staging from the Forward End).

1. Strip the first five sections of staging.
   Follow the same procedure as described for stripping the after end staging.
2. From the fifth section aft to the midship section, fold the staging back as shown in Fig. 148.
3. Remove the bow tower.
   Remove with a crane and place it to one side. Fasten securely to some permanent object.
4. Remove the first two towers on both sides of the ship.
   These are removed completely with struts and spawls in place.
5. Remove the strut from the third tower on each side of the forward end.
6. Check staging around the ship and remove any bottom flight staging which is still in place.

QUESTIONS

1. **Why is it necessary to remove struts and towers at the after end of the way?**
2. **Explain how the staging is removed from the midship section of the ship.**
3. **Explain the procedure followed in stripping a section of staging.**
4. **Why must a certain amount of staging be removed from the forward end of the ship?**
5. **What is meant by "folding back" staging?**
6. **Why is it necessary to remove all bottom flight staging?**

JOB SHEET NO. 31
REMOVING INSIDE STAGING

General Information

Inside staging should never be removed until all the crafts have completed their work. Note particularly whether the electrician has removed the temporary wiring system. The temporary light man must provide several long extension lamps to provide light for removing the staging. These lamps are brought into the tank through the hatch opening, and hung on girders and beams where needed.

Each type of staging is removed by following the method which is quickest and easiest. The following procedure lists in a very general way the steps which are followed:

1. Drop all planking to the deck below.
2. Remove planks through the most convenient opening.
3. Loosen spawls and uprights.
4. Disassemble spawls and uprights.
5. Remove spawls and uprights.
6. Assist burner and chipper in removing clips, brackets, and angles.
7. Remove timbers from the ship.

The procedure for removing the various inside stagings is listed on each specific job sheet. The center tank staging, which is the most difficult to remove, is treated in this sheet.

Tools and Materials

1. Tugger hoist
2. ¾″ bolts
3. Wrench

Other Mechanics Needed: Burner and chipper.

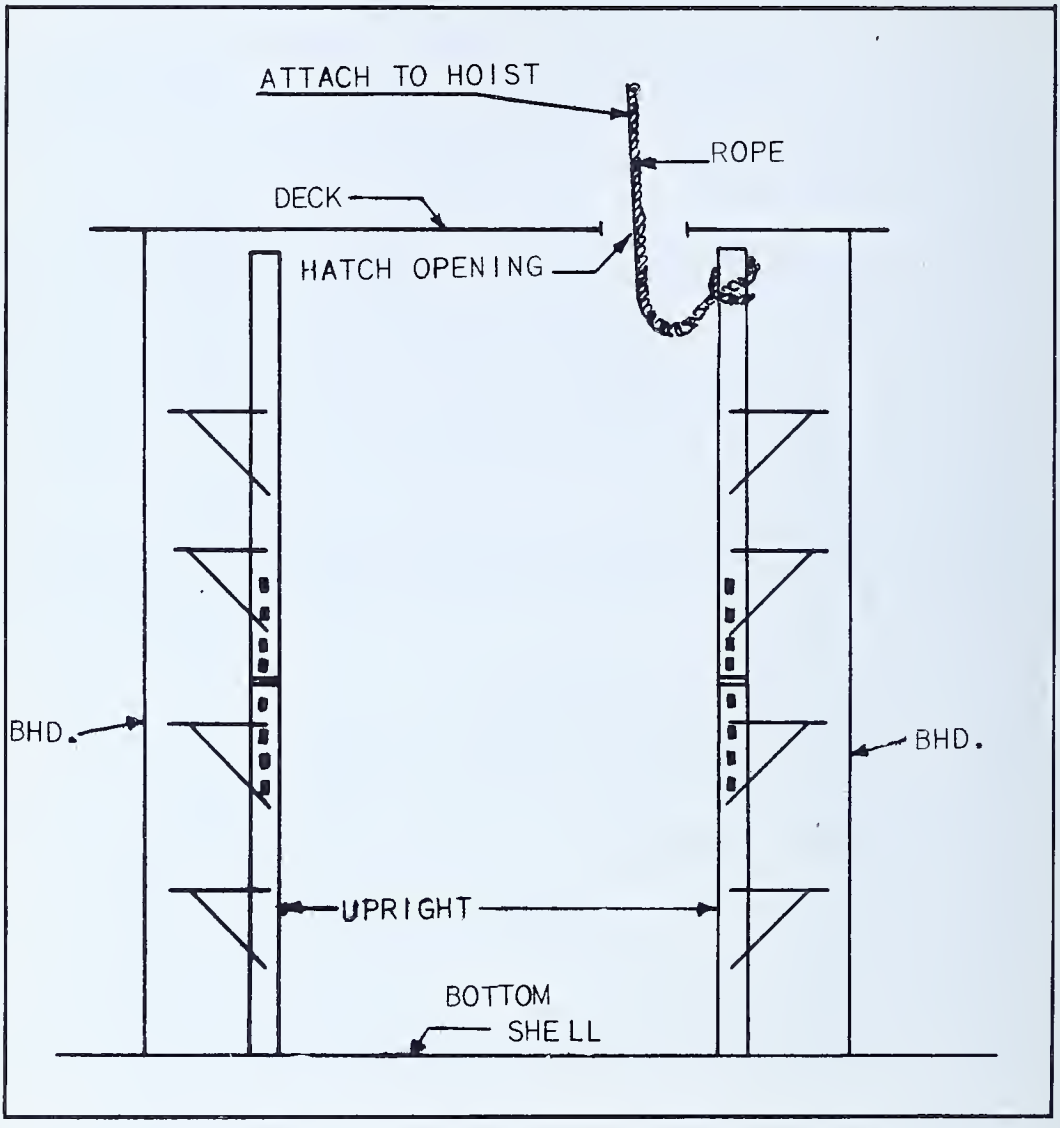


FIG. 149 — *Pulling Side Staging From Center Tank*

PROCEDURE (For Removing Staging from a Center Tank).

1. Set the tugger hoist on deck.

   The hoist must be placed so that the boom will reach the hatch opening and yet be in a position to swing the plank to a convenient location.

2. Fasten tugger hoist to the deck.

   Do this by welding bolts to the deck, so that the bolts will fit into the slots of the hoist legs. Bolt the legs to the deck.

3. Remove the planks from the top staging.

   Remove one or two at a time with a chain and hoist.

4. When the top is stripped, drop the center spawl to the bottom of the tank with the help of the tugger hoist.

   Pass the chain from the hoist through a lightening hole in the girder, and attach around the spawl near the center. Unbolt the spawl at each end and lower to the bottom of the tank.

5. Take spawl apart.

6. Remove spawl from the tank.

7. Pull the side of the staging which is near the hatch opening. See Fig. 149.

   Loosen the uprights from the clips on the tank bottom, and loosen all figure 4 brackets from the side shell. Uprights should never be dropped in one piece, if it is possible to avoid doing so.

   They can be taken apart at the splice after the planks are removed from the figure 4's. If this is done, there is very little chance of dropping a mass of plank and possibly breaking valves or pipe lines.

8. Remove the staging planks.

9. Disassemble the uprights.

10. Remove uprights from the tank.

11. Repeat operations 7, 8, 9, and 10 on the other two sides.

12. Have the burner and chipper remove all clips.

QUESTIONS

1. **How should the top plank be removed?**
2. **Why are the uprights taken apart and not removed in one piece?**
3. **What safety precautions are employed when removing staging?**
4. **Why is a tugger hoist used to remove the planking?**
5. **When should the clips be removed?**

JOB SHEET NO. 32
STAGE BUILDING IN REPAIR

General Information

Many of the same methods and procedures for stage building in construction will also apply for stage building in repair. No definite jobs for staging in repair can be listed since the jobs vary so widely from ship to ship. In most cases a combination of methods must be applied to each particular job.

The tools used by the stage builder in repair are the same as those listed for construction. The most commonly used tools are the brace and bit, saw, and open end wrench. The rope, not commonly considered a tool, is used extensively in hanging staging, supporting spawls, and lowering planks and other staging material into position.

Staging

Stage builders on repair work stage anywhere above the paint line, all interior and all above deck staging such as king posts, masts and stacks.

The outer stagings are usually of a hanging type because the ship is in wet basin, or the position of the work is at such a place on the shell that it would be easier to stage with this type than uprights.

The hanging stages may be of various types such as a straight type hanger, figure 4 type, A type, or a swinging staging.

Outside staging below the paint line when on dry dock is usually performed by the dry dock riggers.

Trestles are erected by crane wherever possible and by hand

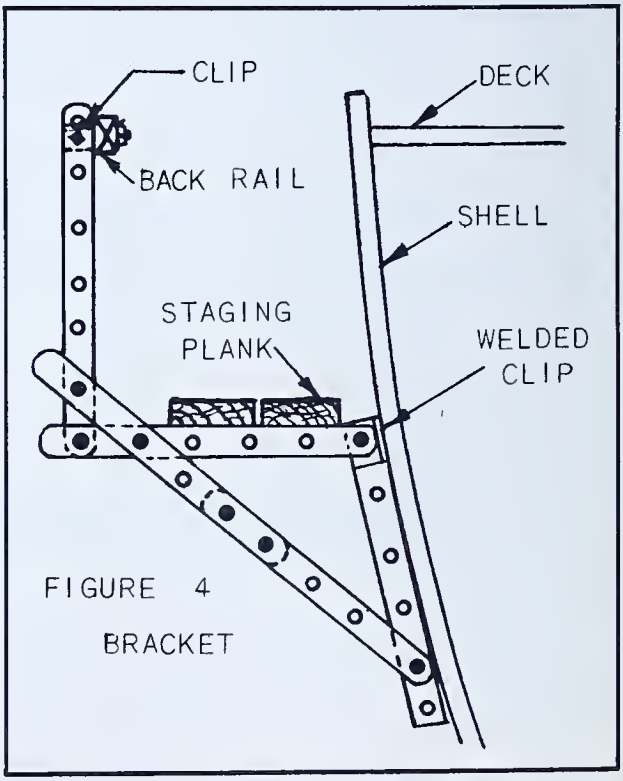


FIG. 150 — *Hanger at Midship*

when the crane cannot reach them. Planks are then placed on the cross members of the trestles to form a staging. This staging is generally used for low repair work as well as the painting of the ship.

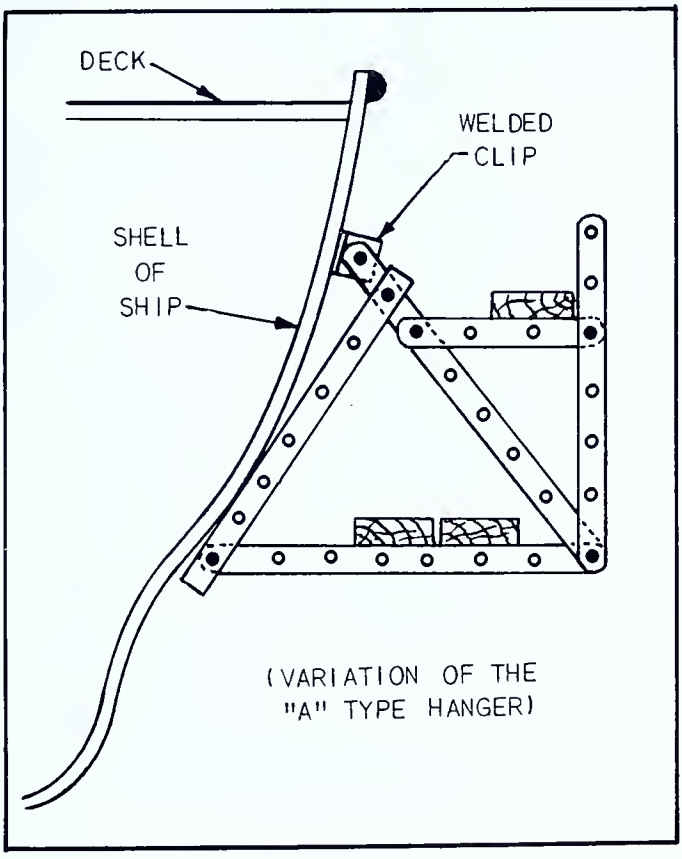


FIG. 151 — *Hanger at Bow or Stern*

INTERIOR STAGING

The disadvantage of staging in repair work is that all interior work must be assembled within the tank. The method is similar to shipway staging. But, due to the overhead deck, the planks must be lowered to the bottom of the tank, and then pulled into position by means of a rope or a rope and snatch block hung above the position of the staging.

On damaged work the staging must be changed to remove and replace steel plates and beams.

This usually demands a complete change of staging which must be made to suit the individual types of work.

This type of staging requires the stage builders to work at hazardous heights and positions.

Staging hangers consist of angle irons, staging brackets, bolts, nuts, and washers.

The holes punched in the angles and brackets should be 15/16, so that $\frac{3}{4}$ or $\frac{7}{8}$ bolts can be used.

The holes in staging brackets are spaced on 4″ centers. The holes in the angle irons are spaced the same, but on both flanges of the angle. The holes are also staggered so that the holes in one flange are halfway between the holes in the other flange. By spacing holes on 4″ centers, adjustments can

be made to suit any condition. In most cases the height of the flights of staging should be approximately 3 ft.

The close flights of 3 ft. are used for riveting, bolting and reaming, fairing, etc. which are heavier types of work than scaling or painting.

After the hangers are put in position, staging planks must be placed on the hangers to form a platform on which the men can work.

The planks are usually lowered from above with a rope. In tying a rope to a plank, a half hitch is put on first, and is then followed by a timber hitch. The half hitch is placed above the timber hitch as a safety precaution. In lowering a plank with a rope, a hitch should be taken around some permanent fixture on the ship to prevent the plank falling, and also to prevent the rope sliding through the hands. Gloves are very useful in staging to protect the hands of the workers and should be worn whenever possible.

The hangers shown in Figs. 150, 151 and 152 are made from staging brackets and clips. The brackets are bolted to a clip which is welded to the shell of the ship. The types shown in Fig. 150 and Fig. 151 are used particularly where a small isolated area must be repaired, and used only when the staging cannot be hung over the edge of the shell. This type is difficult to erect and the erection must be done from a bosun's chair. See Fig. 155. The disadvantage of this staging is that a welder must be employed to weld on the clips, and a burner and chipper must be employed to remove them.

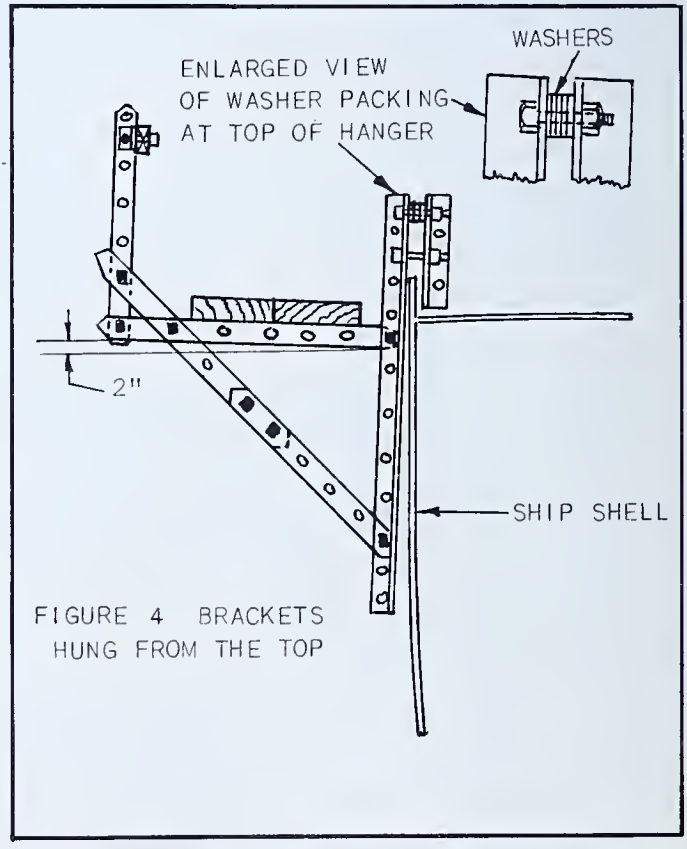


FIG. 152 — *Hanger Hung Over Shell*

Notice particularly the treatment of wooden guardrails. Figure 150 shows the wooden guardrail bolted to a clip, which in turn is bolted to the upright. In Figure

156 the upper 3″ x 10″ plank serves as the guard-rail for the staging. Planks on hangers of this type of staging are usually tied or bolted to the supporting members of the hanger.

Another type of hanger is known as the hanging type. This type eliminates the welding of clips to the shell. Since there are various types of hanging stages, we will illustrate with a figure 4 type shown in Fig. 152. Figure 4 hangers are usually used for work above or even with the deck. Take particular notice of the fastening at the top of hangers. The detail shows that washers are used on the top bolt between hangers and clip. The number of washers are equal to the thickness of the shell over which the hanger is to be placed. Packing this space on the top bolt enables the lower bolt to act as a clamp when tightened, and hold the hanger solidly to the shell.

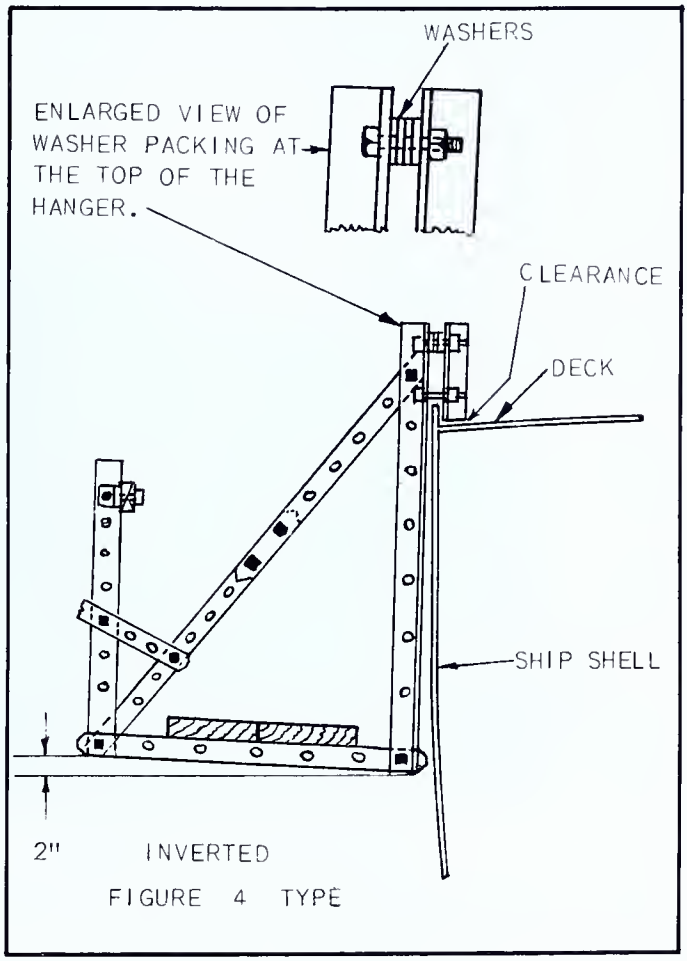


FIG. 153 — *Inverted Hanger Hung Over Shell*

The inside or clamp clip should never rest on the deck (see Fig. 153), for if the hanger would be of sufficient weight, the bolts would probably be sheered off.

Fig. 153 shows another variation of the figure 4 type and is known as the inverted figure 4. This type is used for work on the outside shell.

The length of the hanger depends on the position necessary for the performance of the work.

Notice that the outboard end of the hanger is approximately 2″ higher than the inboard side. The purpose of elevating the outboard end of the hanger is to give the worker a chance to push against the plank upon which he is standing without his foot slipping.

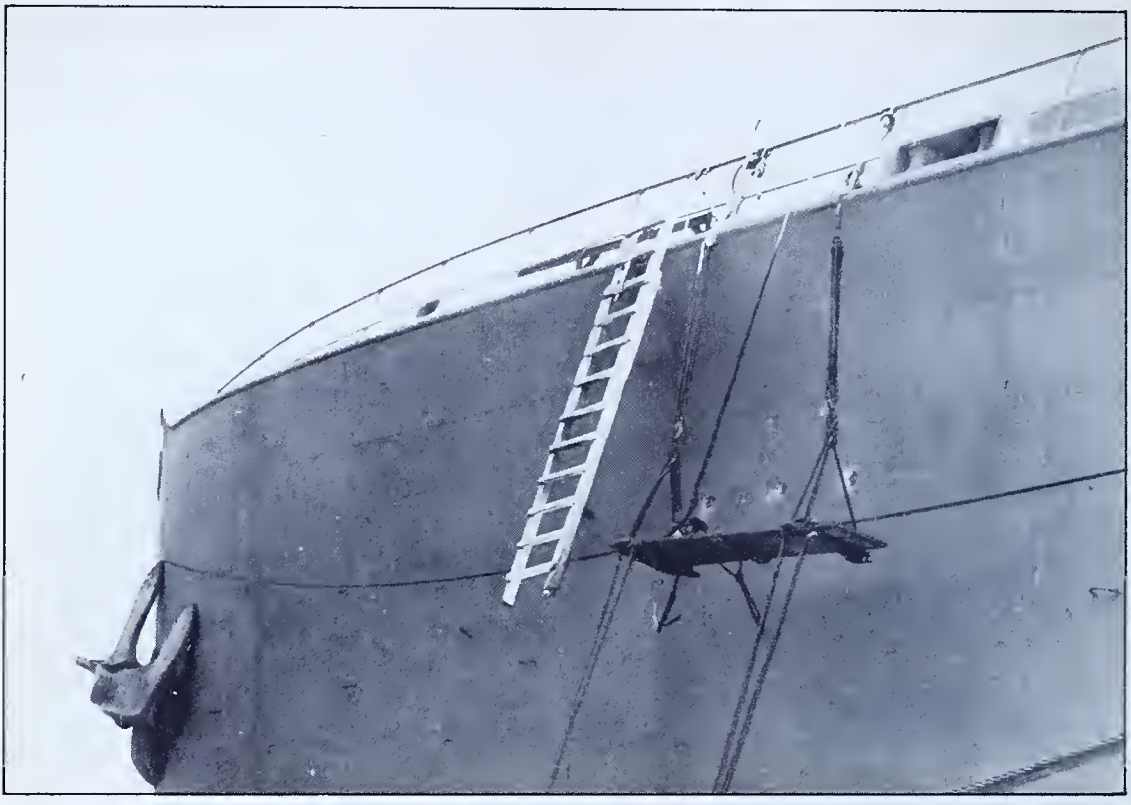


FIG. 154 — *Swinging Stage*

The elevating of the outboard end of hangers should be followed in all stagings.

The bosun's chair is shown in Fig. 155 and is used primarily to lower a workman to a place where a small amount of work is to be done. This chair can be raised or lowered by means of a block and fall upon which the bosun's chair is hung.

The swinging stage is similar to a bosun's chair but of larger capacity and capable of holding more than

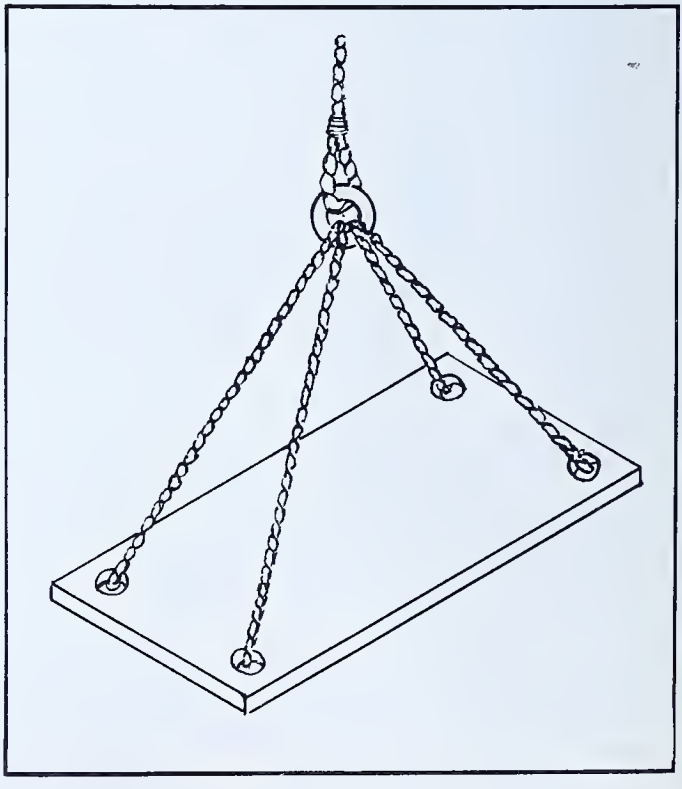


FIG. 155 — *Bosun's Chair*

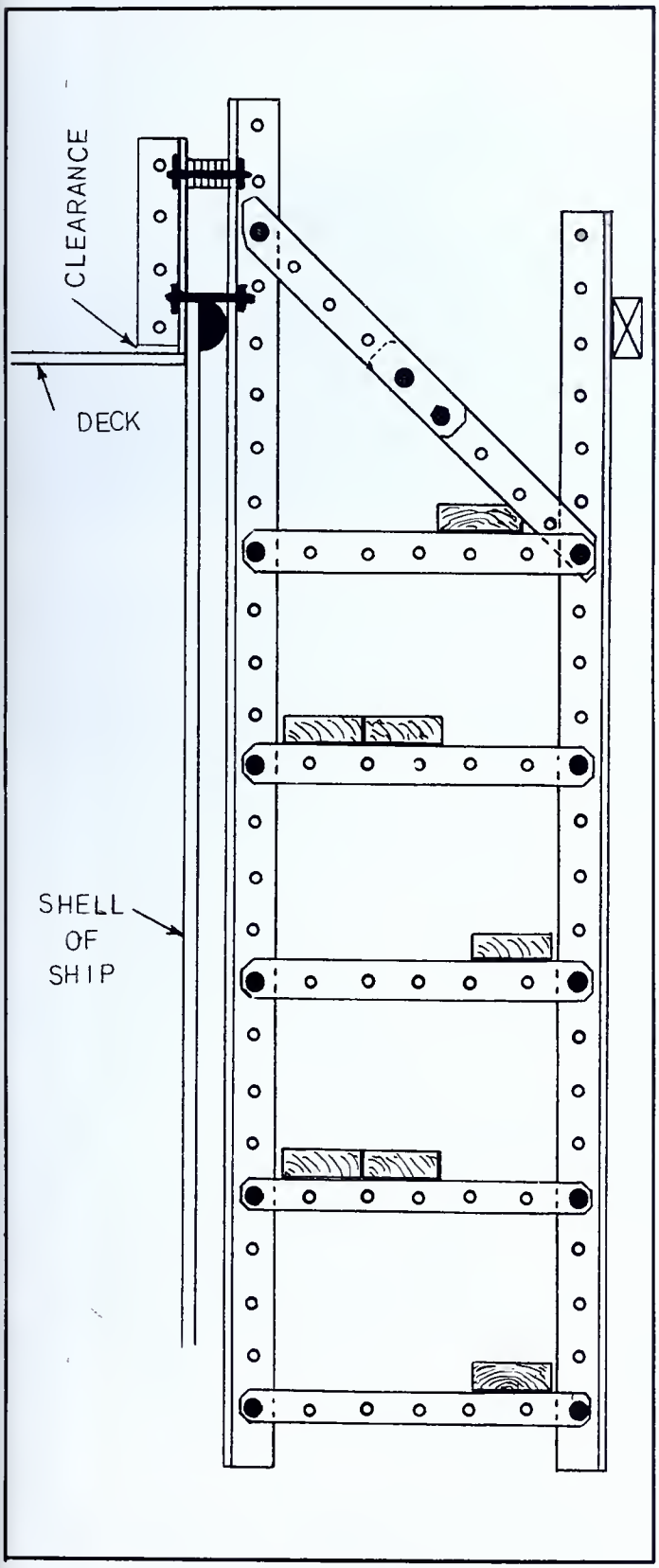


FIG. 156 — *Straight Hanger*

one person. It is hung into position by 2 blocks and falls. The swinging stage is used for small jobs in which more than one person is needed. Sometimes the workers lower the swinging stage into position and use a ladder to climb down to the staging. See Fig. 154 for a good example.

The straight type of staging hanger is shown in Fig. 156. It is used on the straight or midship section of the hull. All hangers are made on the ground to the desired size and then hung into position with the crane and fastened solidly with the bolts in the hanging clips.

To determine the desired length of the hanger, drop a steel tape over the side of the ship and measure the proper length according to where the work is to be performed. Always place the first flight of staging far enough below the top edge of the shell for the men to work at waist height.

The succeeding flights are then moved from flight to flight in order to gain

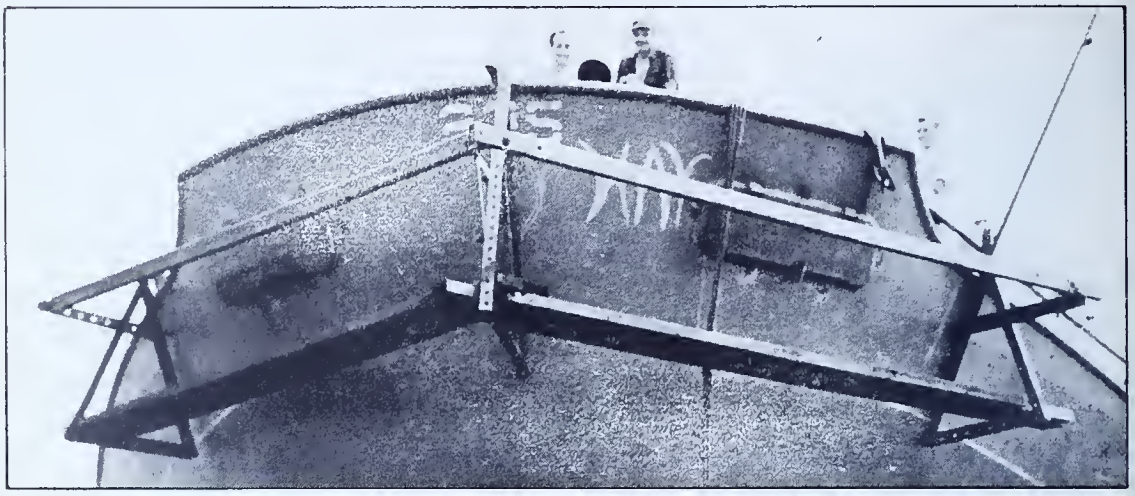


Fig. 157 — *Bow Staging*

any convenient working height. Notice in Fig. 156 that a plank always remains on each flight as a guard rail for the flight below.

The hangers are spaced 15 ft. apart. This provides an 18″ overhang on 18 foot 3″ x 10″ staging plank.

"A" Type Hanger

The "A" type hanger is commonly used on the forward end of a ship where the shape begins to curve under. It is especially adapted for this purpose because it can be constructed to fit the curvatures. Figure 159 is an example of this type. "A" hangers are also constructed on the ground and placed into position with the

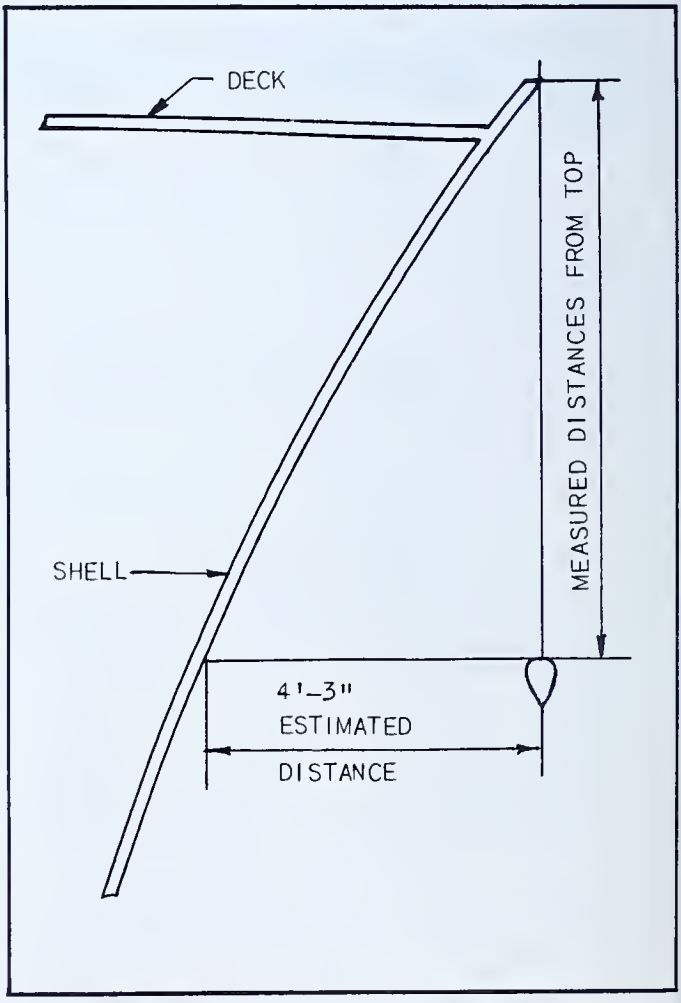


Fig. 158 — *Measuring the Length for a Hanger*

use of a crane. The size of an "A" hanger can be determined by measuring for the length with a steel tape, and by estimating the width from a plumb line as shown in Fig. 158. The "A" hangers should extend as far on the outboard side of the plumb line as the distance from the plumb line to the ship shell. This distance may be more than equal but must never be less. The extra weight of the hanger being on the outboard side helps to balance the hanger and eliminate a possibility of its swinging away from the shell. Because of the curvature of the ship, hangers sometimes swing away.

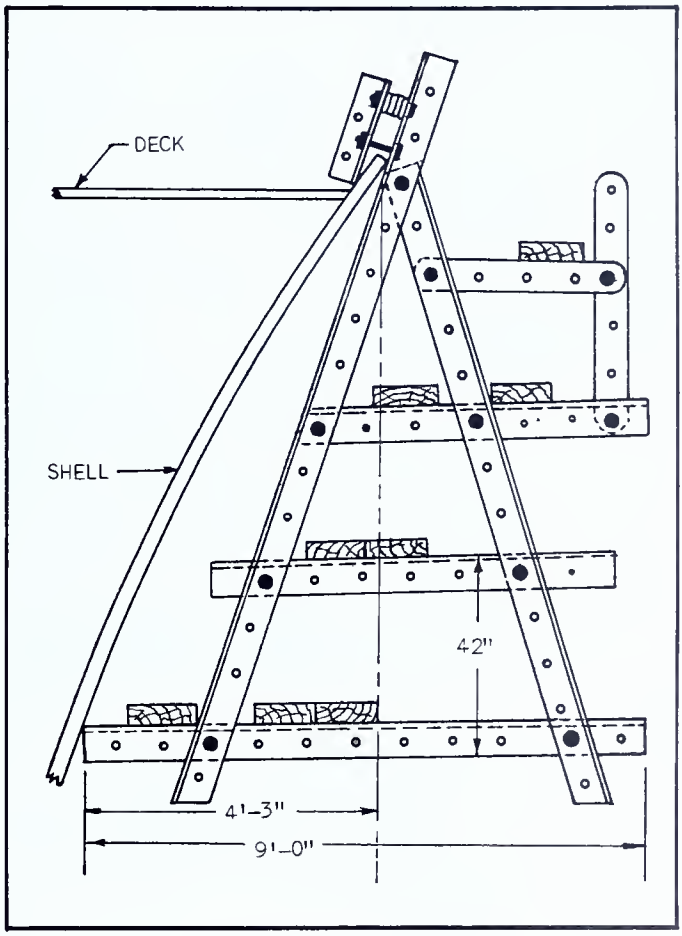


FIG. 159 — *"A" Hanger*

To stop the swinging of a hanger, a clip is welded to the shell in line with the lower part of the hanger. The hanger is then bolted to the clip directly or with a small tie piece of staging bracket. See Fig. 160.

Another type of "A" hanger is used on the stern. Figure 160 shows how this type is adapted to the curvatures of the after end. The size is determined in the same way as shown in Fig. 159. This hanger is also built on the ground and placed into position by the crane.

Another method of hanging stagings when the top shell or sheer plate is damaged or removed is shown in Fig. 161. A block of wood high enough for the outlooker to pass over the edge of the shell is placed on the deck. An outlooker angle of sufficient strength is placed over the block and fastened to a clip which is welded or bolted to the deck. The hangers are then bolted to the extending outlooker as shown in Fig. 161. A staging bracket is then bolted to the outlooker and hanger in such a manner as to form a brace. The purpose of the brace is to prevent the hangers from swaying.

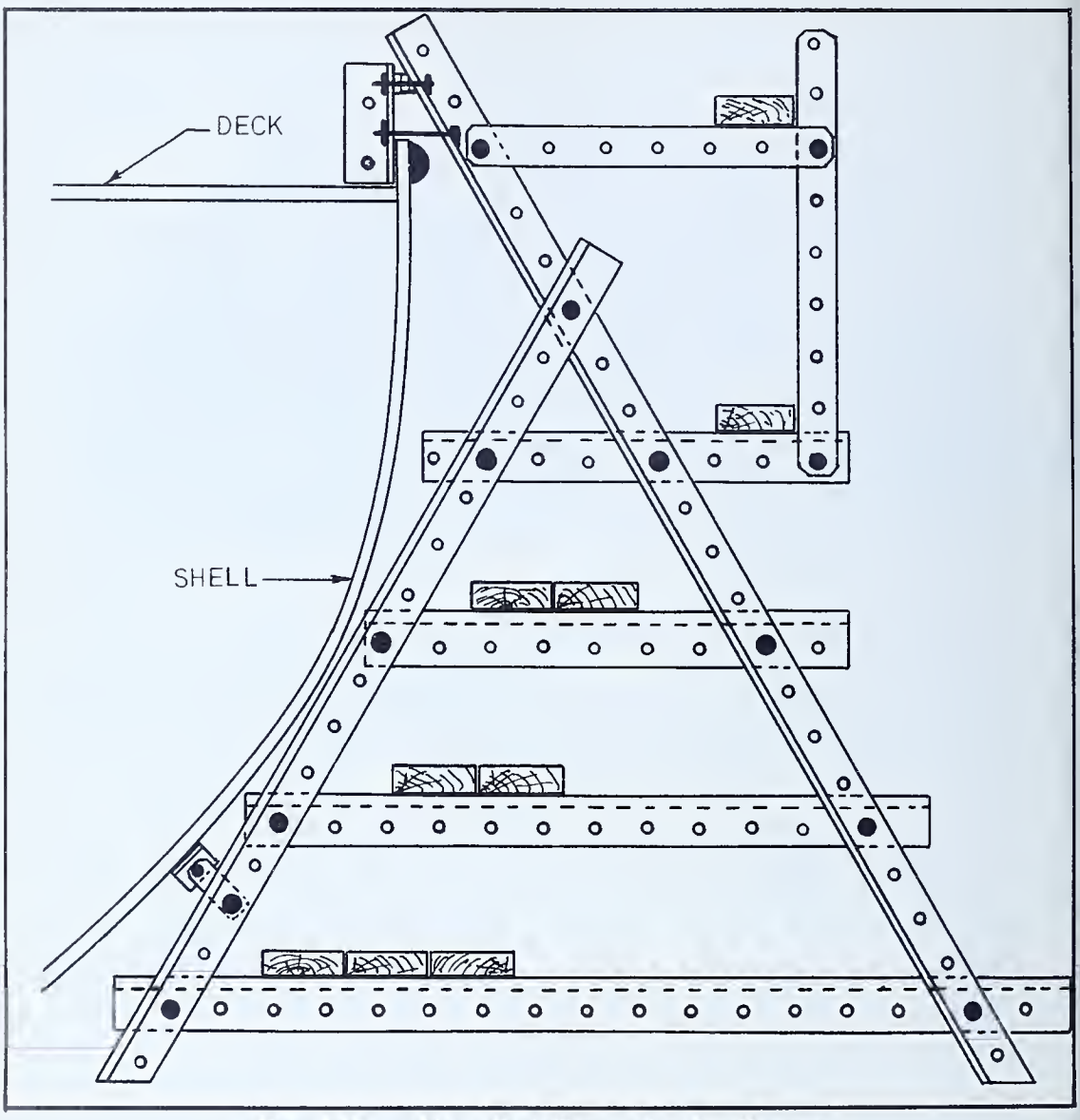


FIG. 160 — *After End Type of "A" Hanger*

The stage builder must provide a ladder for the chipper and burner. He must also work with the burner, holding and moving ladders, and providing other needed assistance.

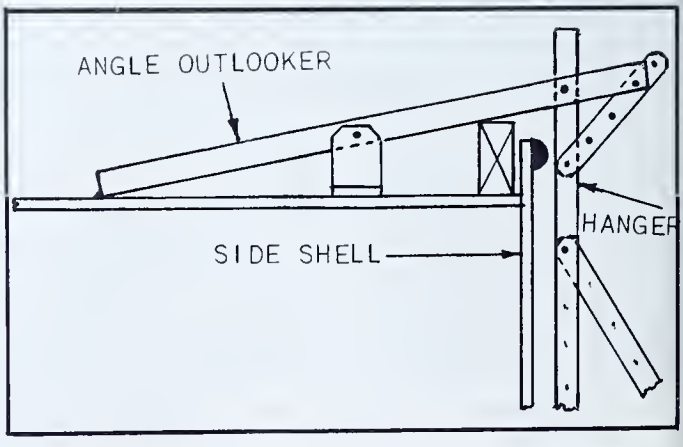


FIG. 161 — *Hanger Free From Sheer Plate*

QUESTIONS

1. Explain how a plumb line is used to determine the size of an "A" hanger.
2. What means are used to prevent an "A" hanger from swinging away from the side of a ship shell?
3. An "A" hanger should be so constructed that the bottom structural member will measure an equal amount inboard or outboard from a plumb line dropped from the top of the ship shell side. Why is this important?
4. What is an "angle outlooker"?
5. Explain the specific procedure for removing all inside staging.
6. Is it more practical to use the crane or tugger hoist when removing staging members from tanks?
7. Who removes clips from the tank walls and deck?
8. How are the sides of staging dropped in the main tanks?

JOB SHEET NO. 33
ERECTING PIPE STAGING

General Information

Pipe staging is patented. It is very easily erected for various stagings such as around a smokestack, king-post, mast, and under decks. The staging equipment consists of floor plates, assorted lengths of pipe with patented fittings for joining one length of pipe to another length. Clamps are provided for securing horizontal pipe to the vertical pipe.

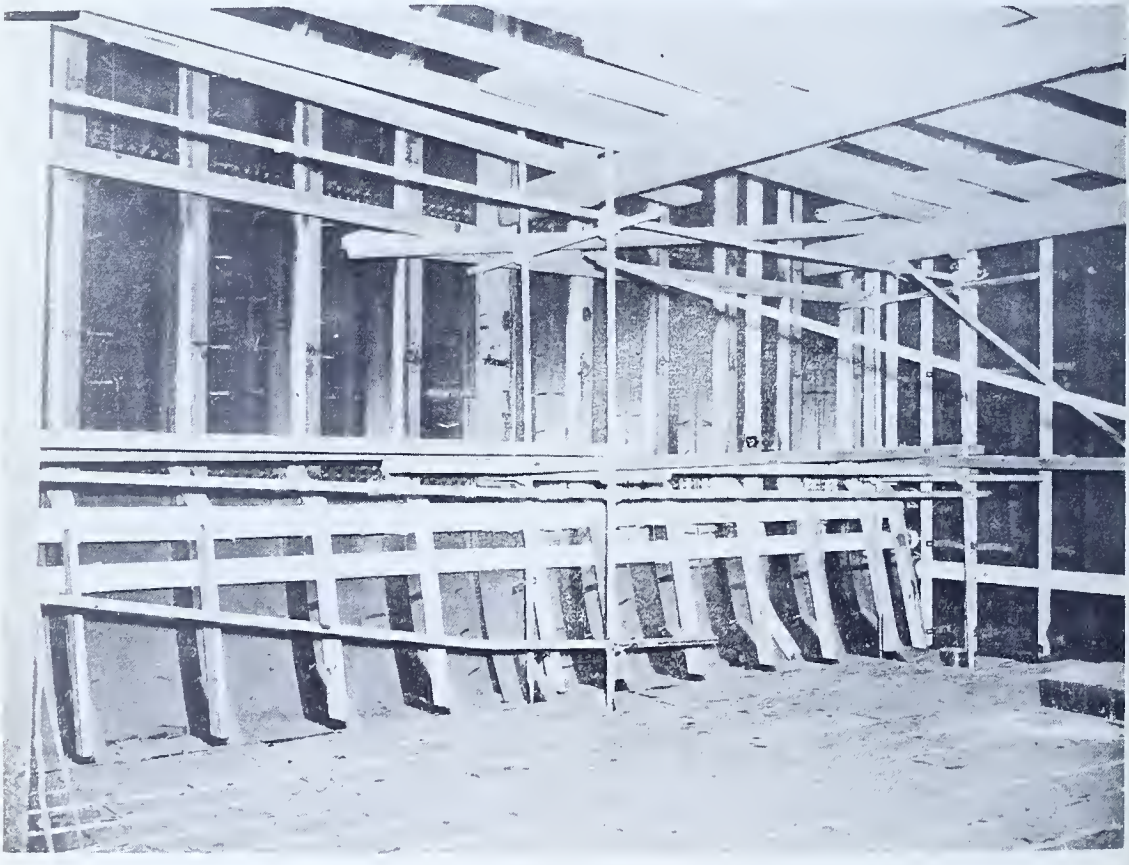


Fig. 162 — *Pipe Staging*

The most common clamp is built at a 90° angle, and the fact that it is 90° makes it an easy problem to erect straight, strong stagings. The adjustable clamp is used for bracing the stages and can be turned to any angle desired. The most common use for pipe staging is around stacks during construction. See Fig. 163.

Pipe staging has been found very useful for installing the frame work for insulation. See Fig. 162. Note that the staging is not fastened to the shell but is self supporting. The fact that the staging is free from the shell gives the workers access to all parts without hindrance. Pipe staging is light, strong, and easy to assemble.

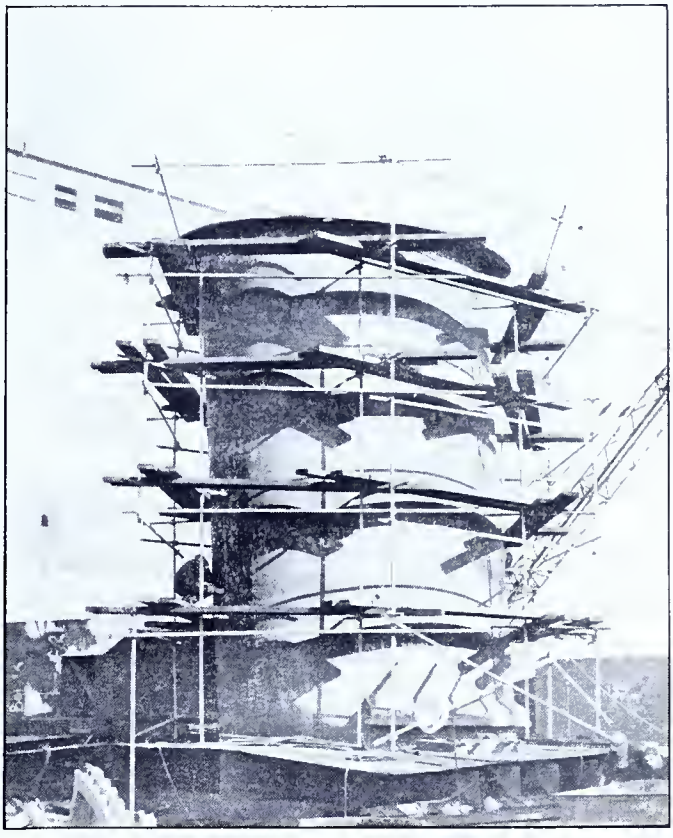


FIG. 163 — *Stack Staging*

Component Parts of Pipe Staging

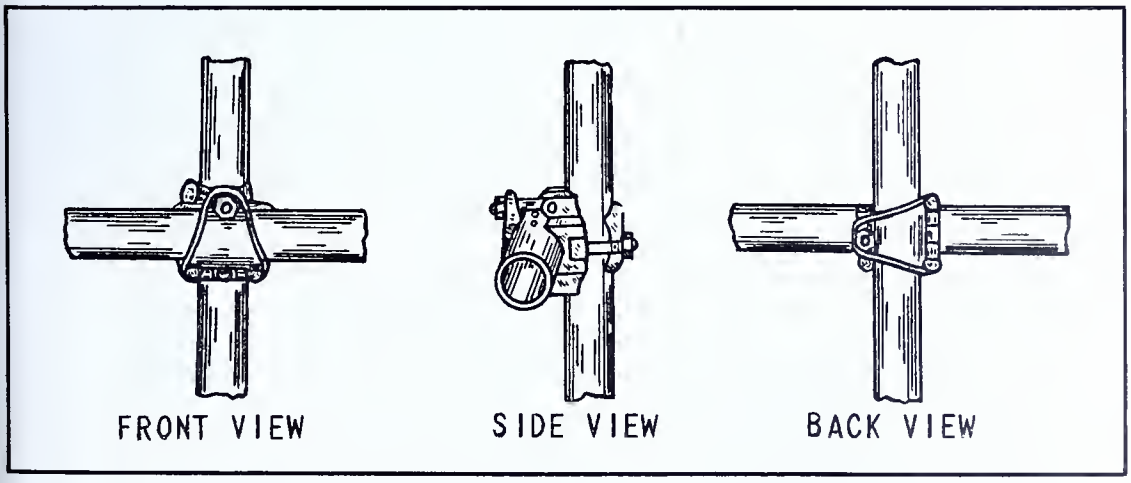


FIG. 164 — *Couplers Used for All Normal Connections Between the Tubular Members*

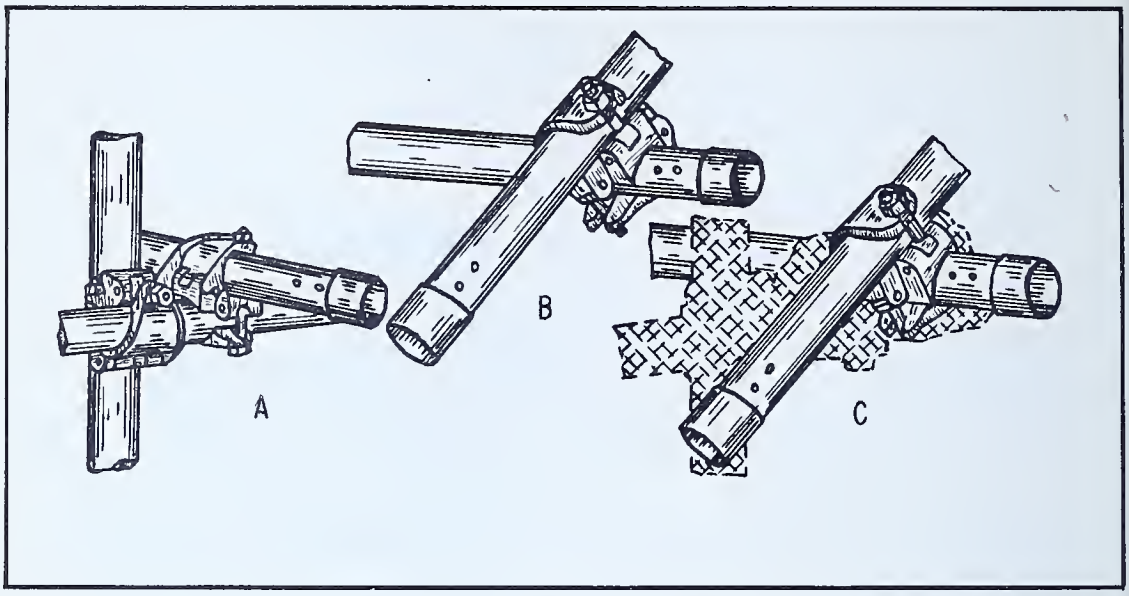


FIG. 165-A — *Typical Connection Between Horizontal and Vertical Members*
FIG. 165-B-C — *Attachment of Diagonal Brace to Horizontal Member*

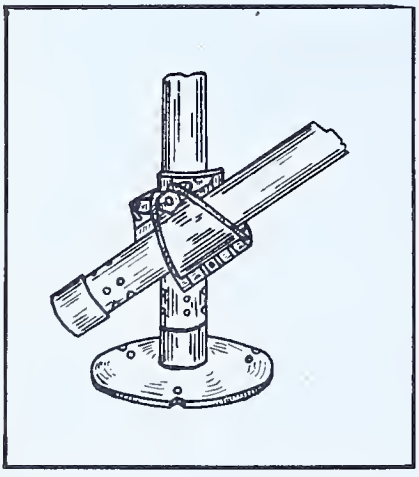


FIG. 166 — *Use of the Coupler*

The general procedure for erecting pipe staging may be outlined as follows:

PROCEDURE

1. Estimate or measure the height for the staging uprights and the number of uprights required.
2. Space the uprights the approximate distance apart (determined by the lengths of tubular scaffolding members used) and prepare to clamp horizontal members of scaffolding in place. (Base, Fig. 167, may be used where necessary. Consult the leader).
3. Select the correct coupler for a right angle connection (see Fig. 164) and clamp it into position.

   Where there is room to raise the scaffolding to a vertical position after clamping, the work may be done on the ground or on the deck and the assembly for one side may be raised to place, after clamping. Where there is not room to follow the foregoing procedure or

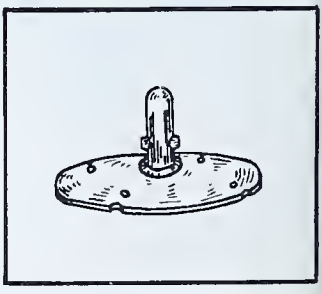


FIG. 167 — *Base*

when the height is too great for safety the uprights may be supported temporarily until there are sufficient couplers clamped in place for the assembly to stand alone.

4. Select tubular members for diagonal bracing (see Fig. 165) and brace the assembly where neces-

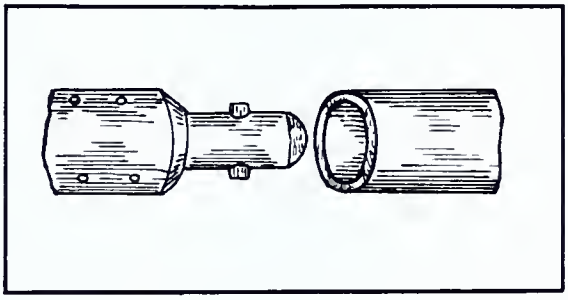


FIG. 168 — *Tubelox Bayonet Fitting*

FIG. 169 — *Tubular Member of the Scaffolding*

sary. Consult the leader for directions in placing the diagonal braces. Figure 165 at "C" shows how the coupler may be adjusted in various positions to support the diagonal brace.

5. Clamp sufficient horizontal scaffolding members in place to support the scaffold planks at the required working heights and locations. Consult the leader.

QUESTIONS

1. **When may tubular staging be assembled on the ground or floor and then raised into position?**
2. **Explain the advantages of tubular staging.**
3. **What tools are needed to assemble tubular staging?**
4. **Outline the procedure for erecting tubular staging in a ship's hold.**
5. **Name the steps which should be followed when erecting tubular staging around a stack.**
6. **How are diagonal braces secured to tubular staging?**
7. **Where should a base fitting be used with tubular staging?**
8. **What steps are necessary to follow when removing tubular staging?**

Part V

SHIP CARPENTRY PROCEDURES

JOB SHEET NO. 1
PREPARING STEEL DECK FOR LAYING WOODEN DECK (PLACING MARGIN BOARDS)

General Information

Wooden decking may be laid directly on steel beams; or if the beams are covered, the decking may be laid over the metal plating. The work of laying deck may be divided into three parts: namely, preparing the deck for laying, the actual laying of deck planks, and dressing and calking the deck. Each division of work will be treated separately.

On tank ships the boat deck, bridge deck, and navigating deck are usually laid with heavy wooden decking. Only the best grade of quarter-sawed lumber is used for decking. Quarter sawed lumber does not split when exposed to severe weather conditions.

A margin board is laid around the edge of the decking. See Fig. 170. The margin board finishes off the outer edge of the deck and provides a butting member for the ends of the deck planks. In some cases it is one-half inch thicker than the decking. The difference in thickness forms a waterway that leads down to the scupper. The margin board also forms a finishing edge around the area.

Special Safety Precaution

Be especially careful when working near the edge of the deck.

Tools

1. Handsaw
2. Hammer
3. Chisel
4. Mallet
5. Adz
6. Brace
7. ½" bit
8. Jack plane
9. Smooth plane
10. Square
11. T-bevel
12. Maul
13. Backing-out punch
14. Chalk line

Materials

Red lead paint
Lamp wicking
Deck plugs
Chalk
3″ x 9″ to 4½″ x 9″ teakwood, Oregon pine, fir, yellow pine
½″ x 3″ to 4″ deck bolts
White lead

PROCEDURE

1. Study the blueprint for size of decking, kind of material, method of fastening, etc.
2. Locate the centerline of the deck. See Fig. 170.

   Centerpunch markings on the heel of the beams will show this location. These centerline markings are established when the beam is made in the shop. If the beams are covered, the centerline marking will be punched on the plating.
3. Snap a chalk line to locate the centerline on each beam.
4. Determine the width of margin board to be used. (See the leader or study the blueprint).
5. Fit a template to the curve of the ship shell where the margin board is to be installed.

   Make the template from thin template stock and fit until it is perfectly tight.
6. Measure the length of margin board needed. (Study the blueprint).
7. Cut and fit together boards to the length found in step 6.
8. Mark out the margin board from the template.
9. Cut out margin board.
10. Fit the board to the steel deck against the shell.
11. Shore over the margin board to hold it in place.
12. Bore holes from bottom up.

    SAFETY: Be careful not to splinter the edge of the hole. Ease up pressure as the bit nears the end of the bore.

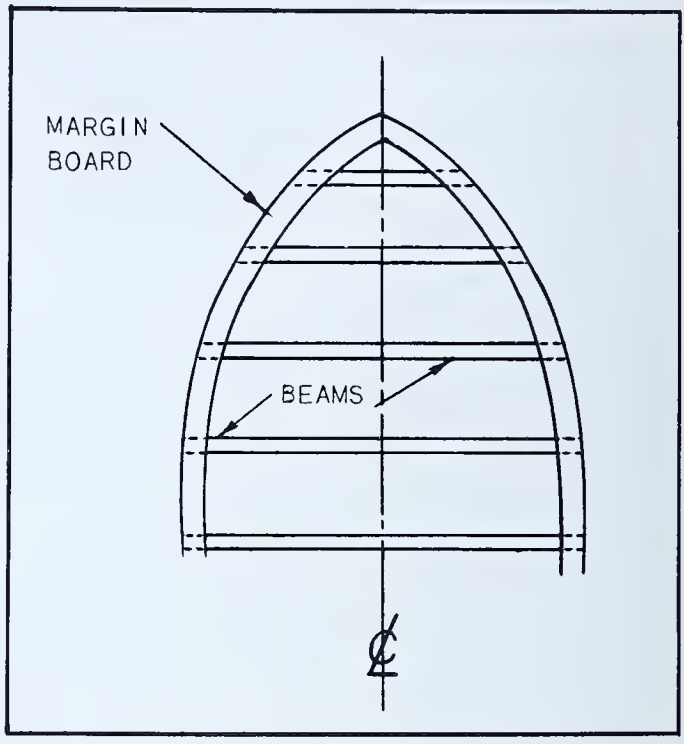


FIG. 170 — *Preparing Steel Deck for Laying Wood Deck*

13. Counter bore with a plug bit from the top down about $\frac{3}{4}$" to provide a pocket for the bolt head.

14. Place lamp-wick grommet soaked with white lead around the head of the bolt.

15. Place the bolt in the hole and set it down snugly.

16. Tighten the bolt.

17. Place heavy white lead over the head of the bolt and in the counter-bored hole.

18. Place the deck plug over the bolt head to match the grain of wood.

19. Drive the plug down tight.

NOTE: Margin boards are fastened to the beams by two methods. See Fig. 171.

METHOD A. When using welded stud bolts, drill a 9/16" hole through the margin board and only partly into the beam to mark the location. Remove the margin board and weld stud bolts at the locations marked. Replace the board and bolt to the beam in the regular manner. Place a lead-soaked grommet around the head and nut of the bolt before tightening. Soak the plug in white lead and drive into place. See Fig. 171 at "a".

METHOD B. Drill holes through the board and the beam; then counter bore the top of the hole to receive the bolt, nut, and plug. Insert the bolt from the bottom up, tighten the bolt, and plug the hole. See Fig. 171 at "b".

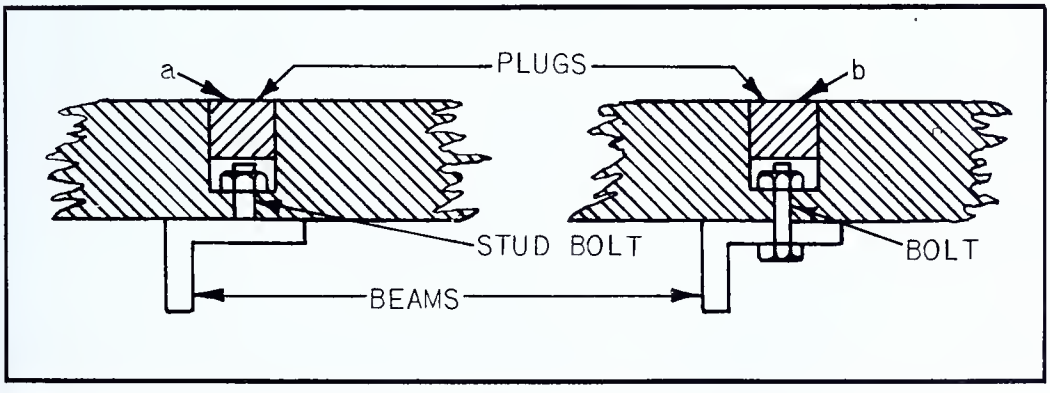


FIG. 171 — *Methods of Fastening Margin Board to Beams*

QUESTIONS

1. How is the center line of the deck located?
2. Why is it necessary to lay deck from a center line?
3. What is a margin board?
4. Explain the purpose of a margin board.
5. What kinds of wood are used in laying deck?
6. What decks of a ship are usually laid with wooden deck?
7. What is a beam?
8. In what respect would the procedure differ if wooden deck were laid over a metal-plated deck?
9. What two methods might be used to fasten the margin board to the beams?

JOB SHEET NO. 2
LAYING WOODEN DECK

General Information

Job Sheet No. 1 gives instructions for the preliminary work of placing margin boards before laying deck. This procedure explains the actual laying of the deck planking. Deck planking is shown in Fig. 172.

The purpose of the wooden decking is two-fold; to insulate the quarters from the intense heat of the sun, and to add to the appearance of the ship. As mentioned before, decking lumber is of the best grade of teak, yellow pine, or fir.

Lay the nibbing strake next to the margin board to receive the nibbed ends of decking. Nibbing eliminates the pointed, feather edge cut on the end of the decking boards. See Fig. 173.

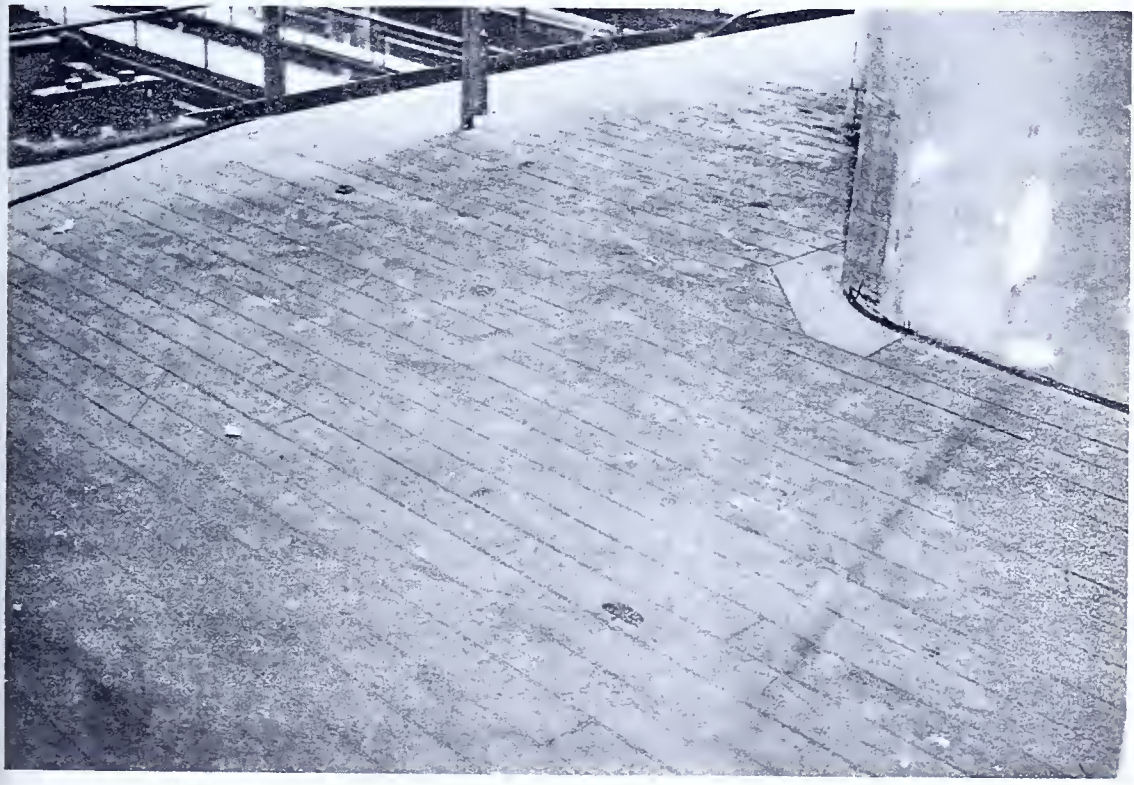


Fig. 172 — *A Section of Finished Decking*

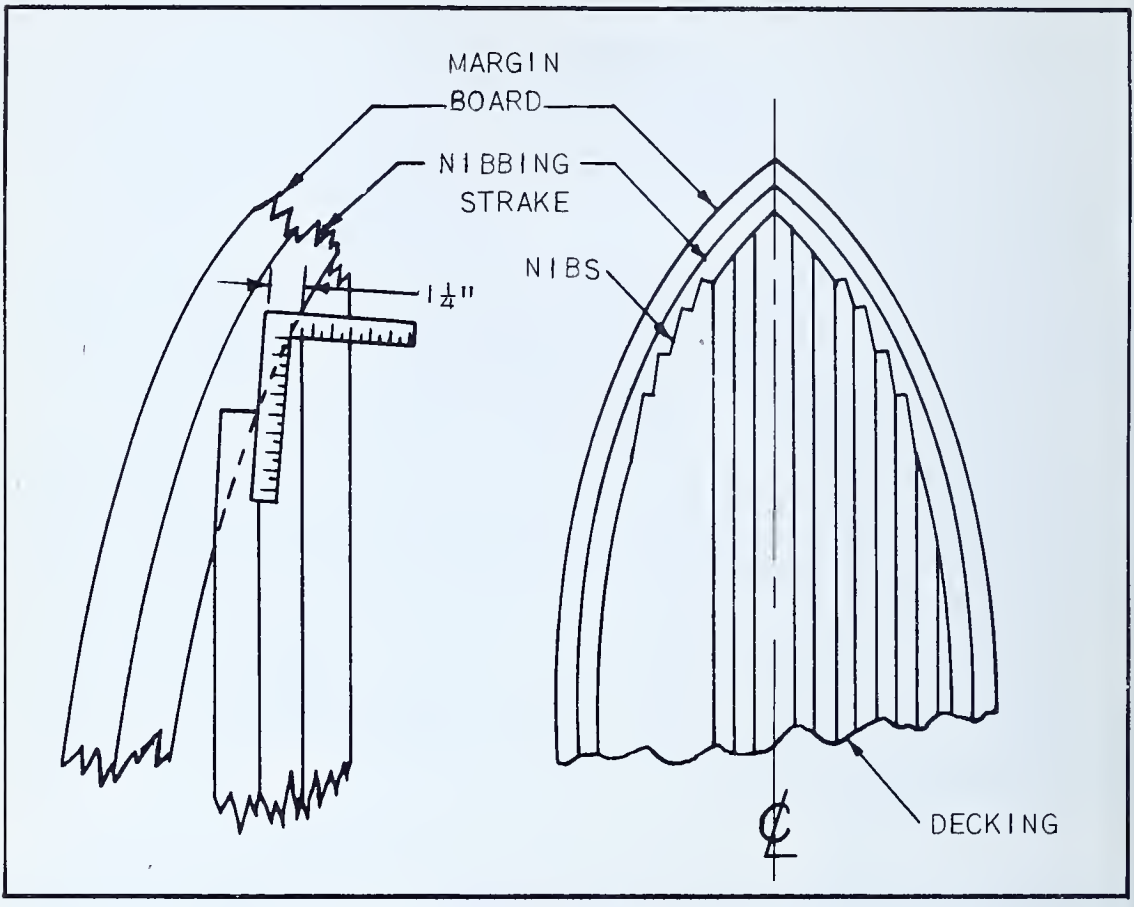


FIG. 173 — *Method of Marking Nibs*

Tools and Materials

1. Bevel
2. Brace and plug bit
3. Wrench
4. Saw
5. 6′ rule
6. Square
7. ½″ bolts
8. Grommets
9. Plugs

PROCEDURE

1. Measure the length of nibbing strake required. (See the leader).
2. Select a piece of regular decking for a nibbing board.
3. Fit, shore, and wedge the nibbing strake tightly against the margin board.
4. Measure the length of the center line for the length of the first two pieces of decking.
5. Cut and fit two pieces of decking to this length.

6. Lay the two center strakes of deck.

The joint formed by the two pieces of plank should be directly over the center line of the deck, see Fig. 173. Clamp the plank into position, sight for straightness, drill bolt holes, and bolt into position.

7. Lay the center strakes until nibbing becomes necessary. Lay four or five strakes at a time.

8. Mark the location of nibs on the nibbing strake. See Fig. 174.

Lay off spaces on a small board equal to the width of decking. Mark the nibbing strake as shown in Fig. 174 by moving the small board outboard one division for each marking.

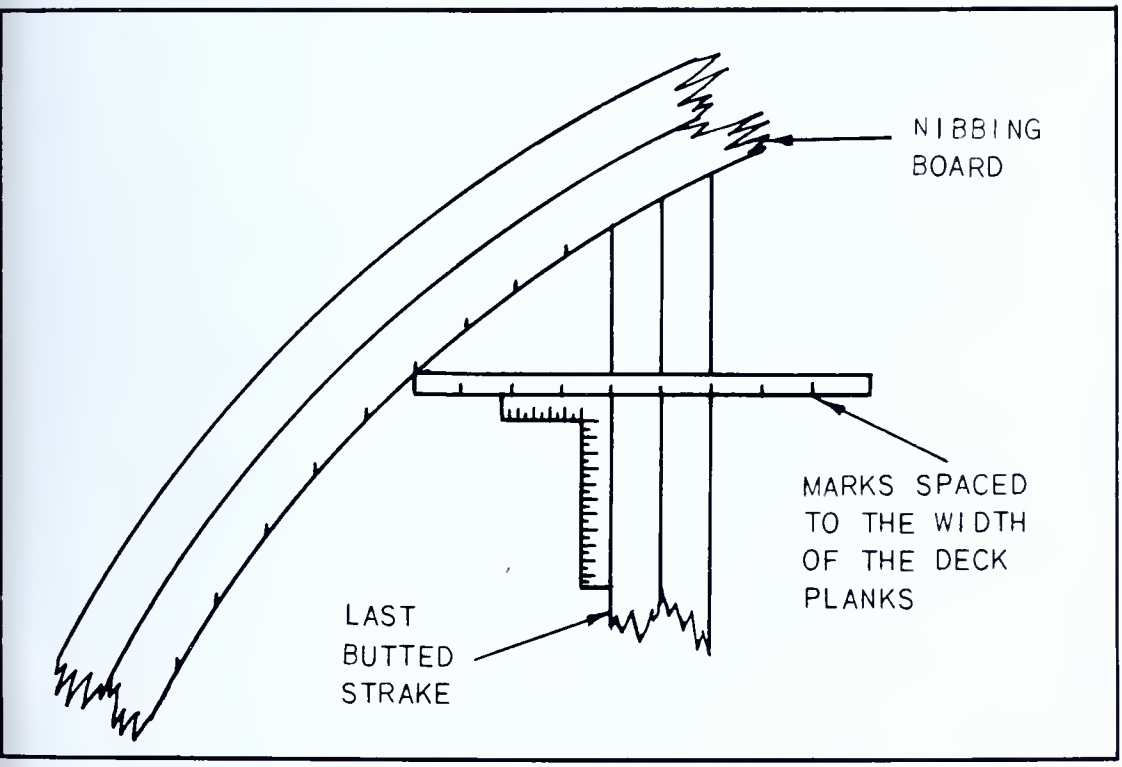


FIG. 174 — *Marking Location of Nibs*

9. Mark out nibs as shown in Fig. 173.

Lay the square with the short blade of the square measuring 1¼" and the large blade aligned with the succeeding point.

10. Remove the nibbing strakes and cut out the nibs with a band saw or a hand saw.

11. Dress with adz and chisel.

12. Fit nibbing strake in place and bolt.

Follow the same procedure for bolting down this strake.

13. Cut decking to fit the nibs.
    (a) Make template of nib by laying a piece of board over the nib, scribing the nib and cutting out.
    (b) Scribe around template on end of decking plank.
    (c) Cut for nib.
    (d) Fit to the nib.
    (e) Drive decking hard into nib and check the fit.
    (f) Saw decking board to length.
    (g) Cut and lay four strakes at a time.

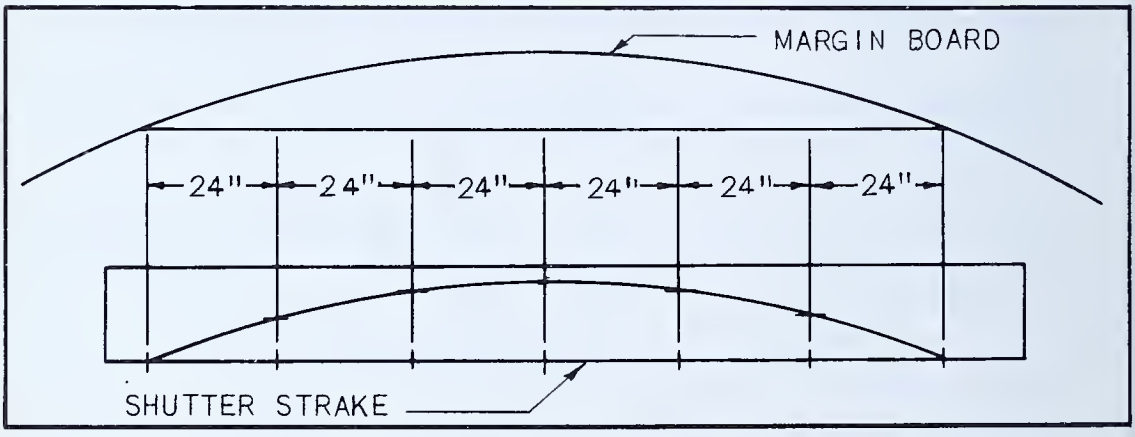


FIG. 175 — *Marking the Shutter Strake*

14. Bolt decking to beams in the usual manner.

15. Continue laying the deck to approximately two feet from each side of the deck.

    Calculate the width of the last strake. If this strake is too narrow, the width of the preceding strakes must be reduced.

16. Fit and lay all but the last strake.

17. Mark out and fit the last strake on the shutter strake. See Fig. 175.

    Measure the distance of the opening at each of the 2 foot markings with a pair of dividers and transfer this distance to the deck plank. Draw a line through the established points.

QUESTIONS

1. **Explain the purpose of nibbing.**
2. **How are nibbings laid out?**
3. **How are nibs laid out and cut on the deck planks?**
4. **What decking strakes are laid first? Why?**
5. **What is the shutter plank?**
6. **How is the shutter plank laid out?**

JOB SHEET NO. 3
*FITTING MARGIN BOARD AROUND VENTILATOR STUMP

General Information

Margins are fitted around ventilator stumps for two reasons: first, to give the deck a neat appearance; second, to prevent damage to the decking when a very heavy ventilator stump has to be removed for repairs.

Tools and Materials

1. Adz
2. Saw
3. Plane
4. Hammer
5. Chisel
6. Mallet
7. Dividers
3. Brace
9. Bit, ½″
10. Wrench
11. 6′ rule
12. Plugs
13. Grommets
14. White lead
15. Calipers

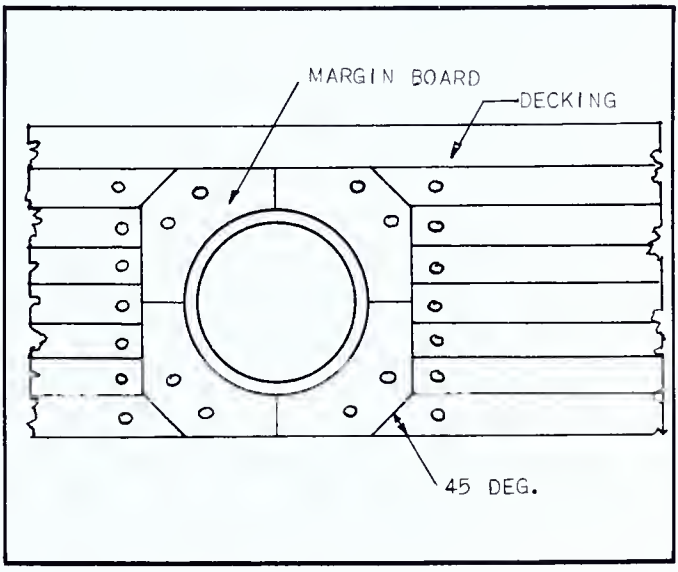


Fig. 176 — *Margin Board Fitted in Place*

Procedure

1. Caliper the diameter of the ventilator stump.
2. Determine the radius of this diameter measurement.
3. Set the dividers to this radius.
4. Strike a quarter circle on a piece of template wood.
5. Cut template wood to this curved line, forming a hollow.
   Since the margin board is made in four equal parts, only one quarter (90 degree) template is needed.
6. Try the radius curve for fit against the ventilator stump.
7. Mark the quarter template butts to a 45 degree angle. See Fig. 176.
   (The length of the butt meets the angle of the decking strip).

*Adapted from "Ship Carpentry," Alabama State Department of Education.

8. Cut butts and fit the template.
9. Square off the corner as shown in Fig. 176.
10. Lay out four pieces from the template.
11. Cut out materials.
12. Fit the four quarter pieces around the ventilator stump.

    This operation requires skill and accuracy; all joints must be fitted neatly. Some ventilator stumps have a flange which is riveted to the steel deck; where this is found, the margin must be rabbeted to fit over the flange.

13. Remove margin pieces and apply a heavy coat of red lead to the ventilator stump and to the deck around the stump.
14. Place the margin board into position and wedge hard against the ventilator stump.
15. Bolt to the deck.
    (a) Bore holes with a 9/16″ bit and at the locations shown on Fig. 176.
    (b) Counterbore for bolt head.
    (c) Place lamp wick grommet covered with white lead around the head of the deck bolt.
    (d) Place bolt and drive down.
    (e) Tighten bolt.
    (f) Plug the hole.

QUESTIONS

1. **Why are margins placed around ventilators?**
2. **Why are corners squared on the margins?**
3. **What is a template?**
4. **How many templates are cut for laying out the margin boards? Why?**
5. **Explain the laying out and cutting of the template board.**

JOB SHEET NO. 4
DRESSING AND CALKING DECKS

General Information

No matter how carefully a deck is laid, it will not be perfectly straight and smooth on the top. Dressing is the process of cleaning and smoothing the deck for calking and finishing. This work is done with an adz and plane, and finally a sanding machine. All of the work except the final sanding is done diagonally across the grain.

The finishing operation is usually completed a few days before the ship leaves the dock.

Special Safety Precaution

Exercise care in using the adz.

Tools and Materials

1. Calking tools
2. Cotton string
3. Oakum
4. Marine glue
5. Adz
6. Plane
7. Sanding machine
8. Chisel
9. Mallet

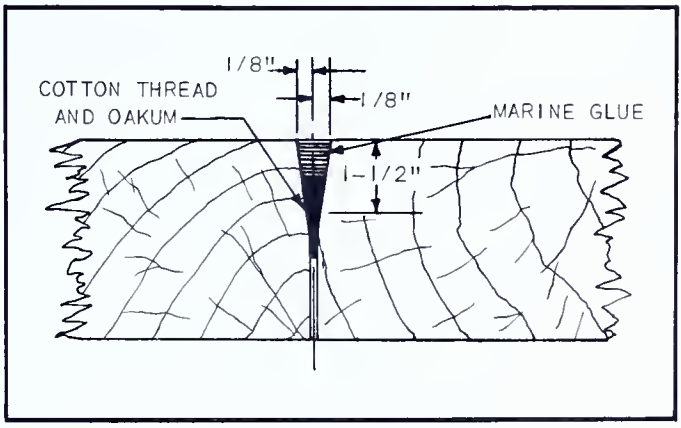


Fig. 177 — *A Calked Seam*

Procedure

1. After the deck has been laid, chisel out all the butt joints for calking.
   All joints should be chiseled out to the same width and depth.

2. Fair off the deck.
   (a) Pick out the high spots by sighting.
   (b) Cut down with adz.
   (c) Plane smooth.

3. Calk the deck seams. See Fig. 177.
   (a) Run a thread of cotton in the joint.
   (b) Run two or more threads of oakum.
   The thread and oakum is forced into the seam with small calking tools.

4. "Pay up" the seams with marine glue.

   Run marine glue into the seam until it is completely filled. Allow the glue to dry and scrape off excess glue with a scraper.

5. Sand the deck.

QUESTIONS

1. **What is calking?**
2. **What does "fairing a deck" mean?**
3. **Why are seams calked?**

JOB SHEET NO. 5
SETTING WINDLASS FOUNDATION

General Information

The windlass foundation is one of the larger foundations to be laid. Smaller foundations, for machinery, etc., are placed similarly.

The work of the carpenter cannot be begun before the shipfitter has located and placed the flat bar and gutter. See Fig. 178.

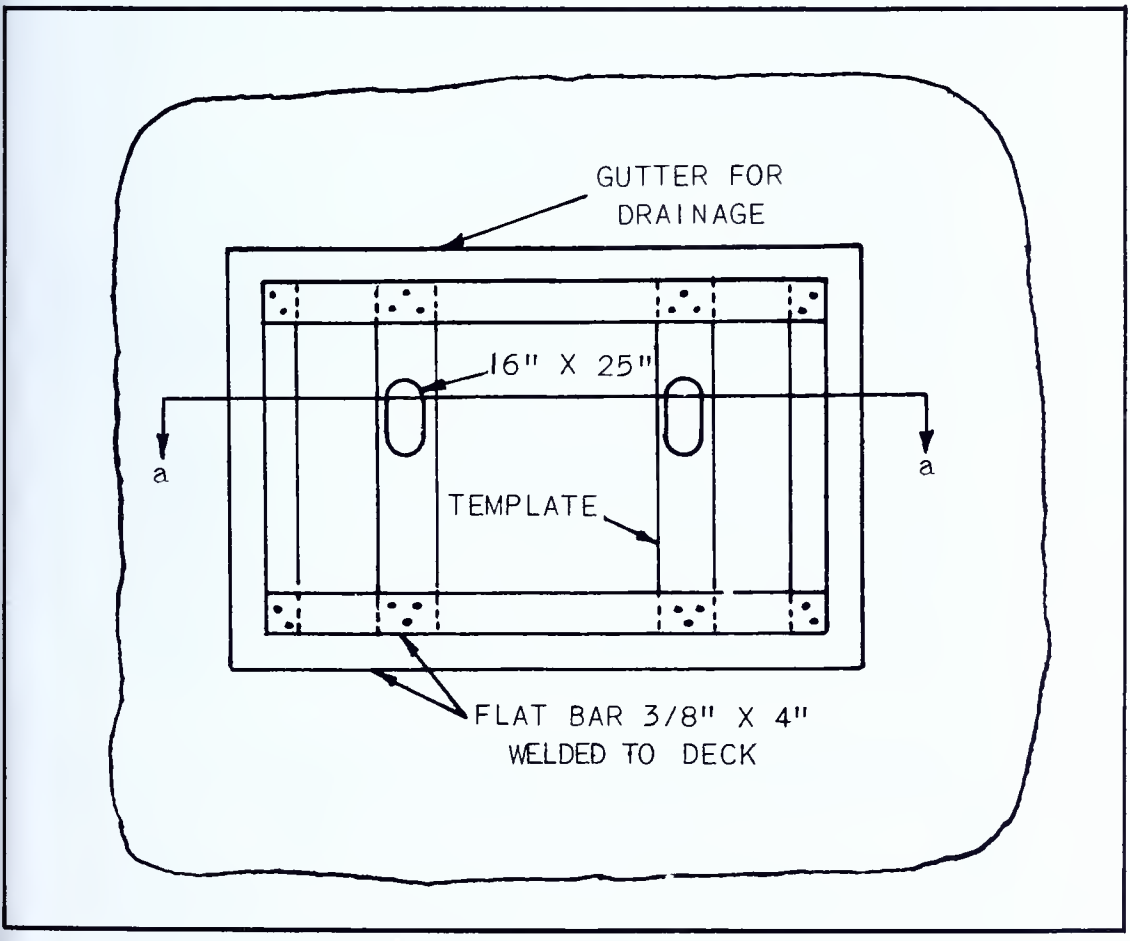


Fig. 178 — *Windlass Foundation*

Tools and Materials

1. Adz
2. Plane
3. 6′ rule
4. Calking tools
5. Hammer
6. Drill and 9/16″ bit
7. Level
8. Straightedge

OTHER MECHANIC NEEDED: Painter.

PROCEDURE

1. Make a template to fit the windlass bed.

   The template of the bed is made by nailing together pieces of template board (approximately ¼″ x 5″) as shown in the top view of Fig. 178. This template is necessary so that the planks can be scribed and cut in the shop to exact size of the windlass bed. The template also permits the two windlass holes to be scribed on the planking and cut out in the shop.

2. Take the template to the carpenter shop.

   The shop carpenter will surface the planks and cut the outgage on the top edges. He will fit the planks together, edge to edge, lay the template on the assembly, mark the two holes and the outer edge of the template and cut out the planks on the established marks.

3. Have the cut planks brought to the ship.

4. Have a painter paint the windlass bed.

5. Lay out the holes for bolts which will hold down the planks.

   Since all planks are the same width, it is a simple matter to lay out the bolt holes on the bed. Each plank is secured to the deck with two bolts in each end and one bolt in the center.

6. Drill 9/16″ holes.

7. Lay one layer of tar felt in the bed.

   The purpose of this felt is to prevent the moisture from drawing through the metal into the wood, thus preserving it.

8. Drill holes through the plank.

   The drilling operation must be done from the under side of the deck.

9. Counterbore the tops of the planks for the bolt head and plug.

10. Place and tighten bolts.

    Use grommets which have been dipped in white lead and place them under the head of the bolt and under nut. See Fig. 179.

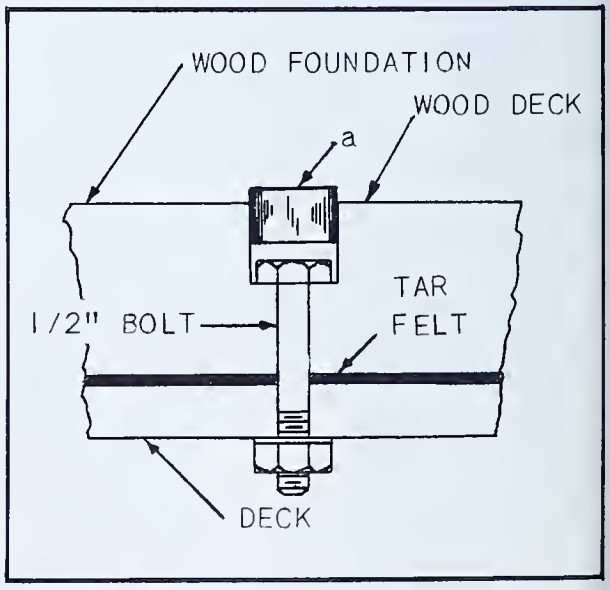


FIG. 179 — *Method of Bolting Plank to Deck*

11. Dress off the tops of the plugs level with the wood deck. See Fig. 179.

12. Fair the tops of the planking.

The top of the planking is cut down roughly with an adz and then planed smooth and level with a plane. Check with a straightedge. See Fig. 180.

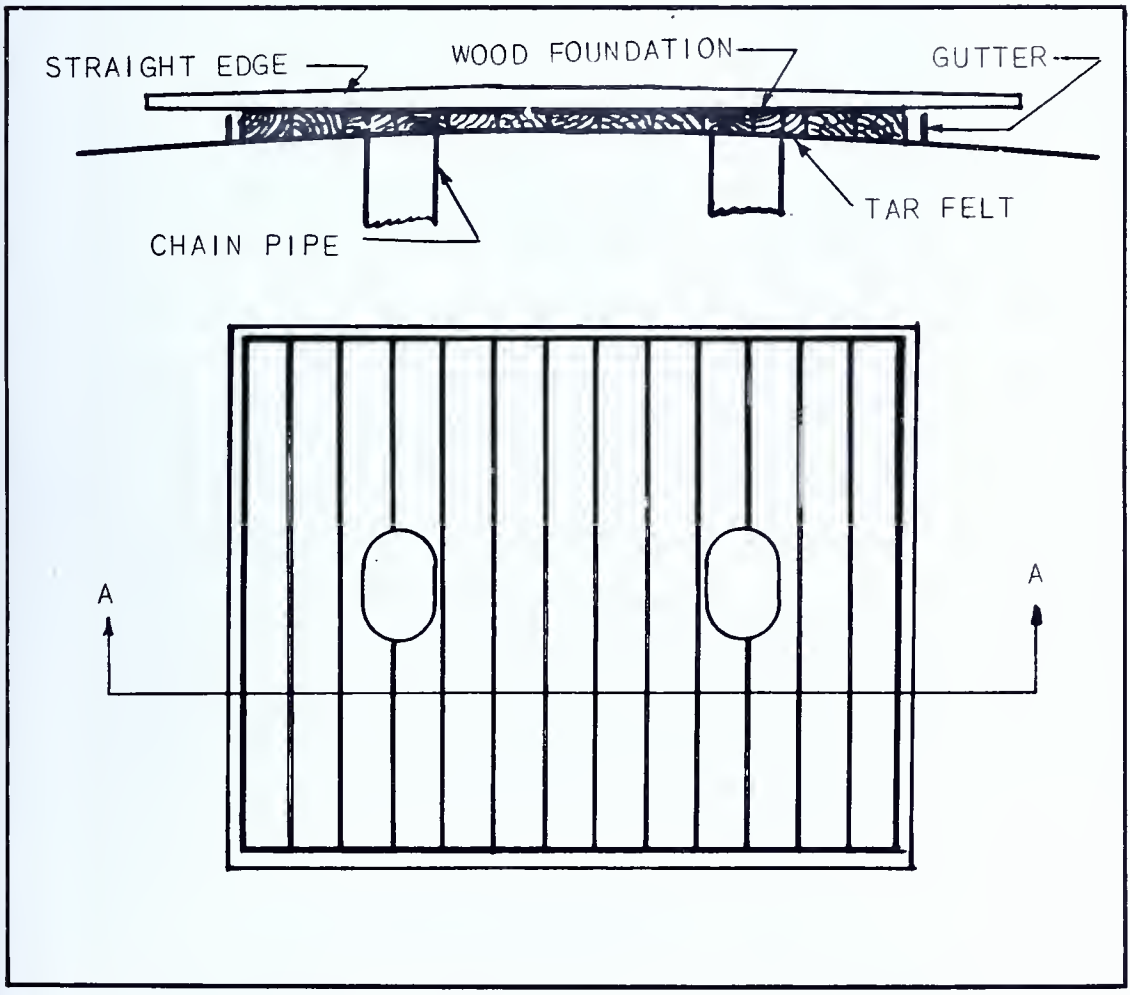


FIG. 180 — *Fairing the Tops of Planking*

13. Calk the seams or joints of the plank.

(a) Run a thread of cotton in the joint.

(b) Run two or more threads of oakum.

(c) "Pay up" joint with marine glue.

(d) Scrape off excess glue with a scraper.

14. Have the painter paint the foundation.

Holding a Windlass Foundation to the Deck Without Drilling Holes Through the Deck

There is another method of holding a foundation to the deck that eliminates drilling holes in the deck top. See Fig. 181. When this method is used there is no likelihood of leaks and the use of grommets is eliminated.

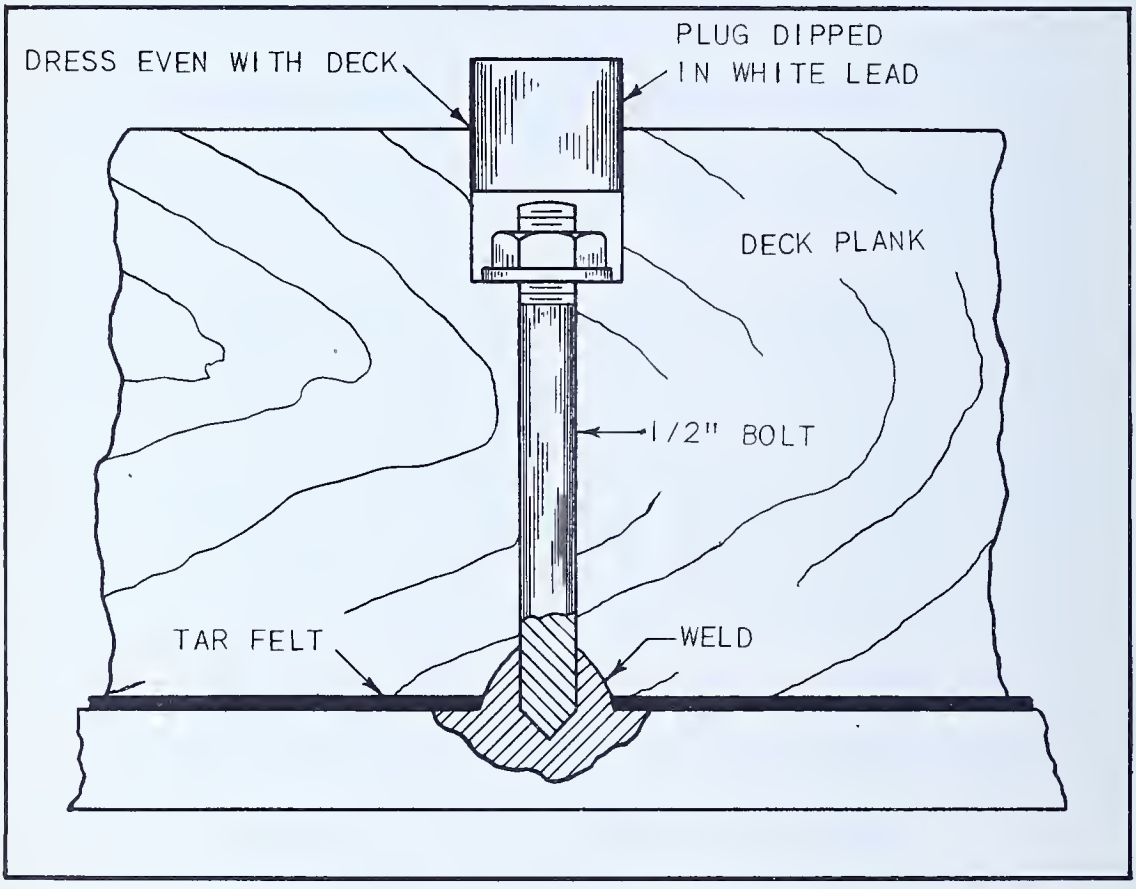


Fig. 181 — *Headless Bolt Welded to Deck*

Laying the Wood Foundation

Procedure

1. Place the wood foundation plank in position inside the retaining bar.
2. Consult the leader or the blueprint for the location, and drill holes through the wood and into the steel deck $\frac{1}{8}$" deep, which is just about deep enough to mark the deck.
3. Remove the wood foundation plank.

4. With the jig, shown in Fig. 182, place the headless steel bolt, threaded end up, in position on the deck so the pointed end of the steel bolt will register in one of the spotted drill marks made in step 2.

5. Weld the bolt in place as shown in Fig. 181.

6. Counterbore the top side of the wood foundation for the plug which is to cover the top of the headless bolt after the nut is placed.

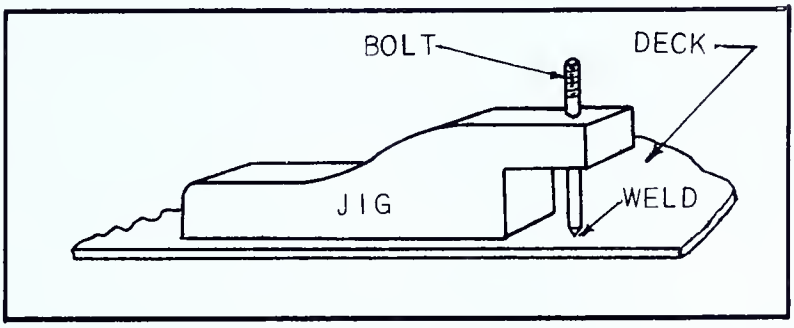


FIG. 182 — *Welding Jig*

7. Place tarred felt on the deck over the foundation area.

8. Drop the planks over the bolts.

9. Fasten the planks down by means of a nut.

10. Tighten the nuts snugly with socket wrench.

11. Dip previously prepared plugs in white lead and drive the plugs home.

The top of the plug which projects is dressed off even with the deck. See Fig. 181. The procedure for setting a windlass foundation in using the headless bolts as here described is the same as outlined previously in this job sheet.

QUESTIONS

1. **What work by other crafts must be completed before the ship's carpenter can begin work on the windlass foundation?**
2. **What is a grommet?**
3. **What is the purpose of grommets?**
4. **Explain the purpose of using a template on this job.**
5. **What is meant by "fairing the planks"?**
6. **Why are seams calked?**
7. **What size hole should be drilled to accommodate a ½" bolt? Why?**

JOB SHEET NO. 6
LAYING CEILING IN CARGO HOLDS

General Information

The sleepers and ceiling planks are the floor of the ship in the cargo holds. The purpose of the cargo ceiling is to keep the dry cargo from resting on the steel bottom which in many cases is wet from sweating and from leakage. This, in many cases, would damage the cargo. The ship must be inspected before starting this job since inspection would not be possible after the ceiling is laid.

The ceiling bottom is to be covered with tar composition paint before sleepers and ceiling planks are laid. The paint prevents the metal from rusting. Have the tank top inspected before beginning to paint.

A sleeper is a foundation piece for the ceiling or tank top. The usual size of the sleeper is $1\frac{3}{4}''$ x $2\frac{3}{4}''$ and a required length. The size of sleepers is sometimes changed to suit different conditions or upon request of an inspector.

Sleepers are placed over the frame of the interbottom to insure the load of the cargo being carried by the strength of the boat. If the sleepers are not placed over the frames, the cargo load is carried by the tank top plates and this weight will likely cause a leak which will result in ruining the cargo.

The interbottom frames run both athwartships, and fore-and-aft, so the sleepers can be placed in either direction. If the sleepers are placed athwartship, and the ceiling is placed fore-and-aft (see Fig. 183), the ceiling usually lays smoothly, due to a camber which is found in some tank tops.

Margin planks are laid on top of the sleepers with the edges against the bilge bracket. Margin planks form a straight surface where the bilge ceiling meets the planks, thus ensuring a tight joint.

When starting to lay the ceiling, place a row of planks in the center of the tank top and spike them to the sleepers. Continue placing planks until the tank top is completely covered.

Manhole frames and covers are built for each manhole as the laying of the ceiling planks progresses. This is necessary to provide openings through which workmen may enter the interbottom without removing ceiling planks. See Fig. 184.

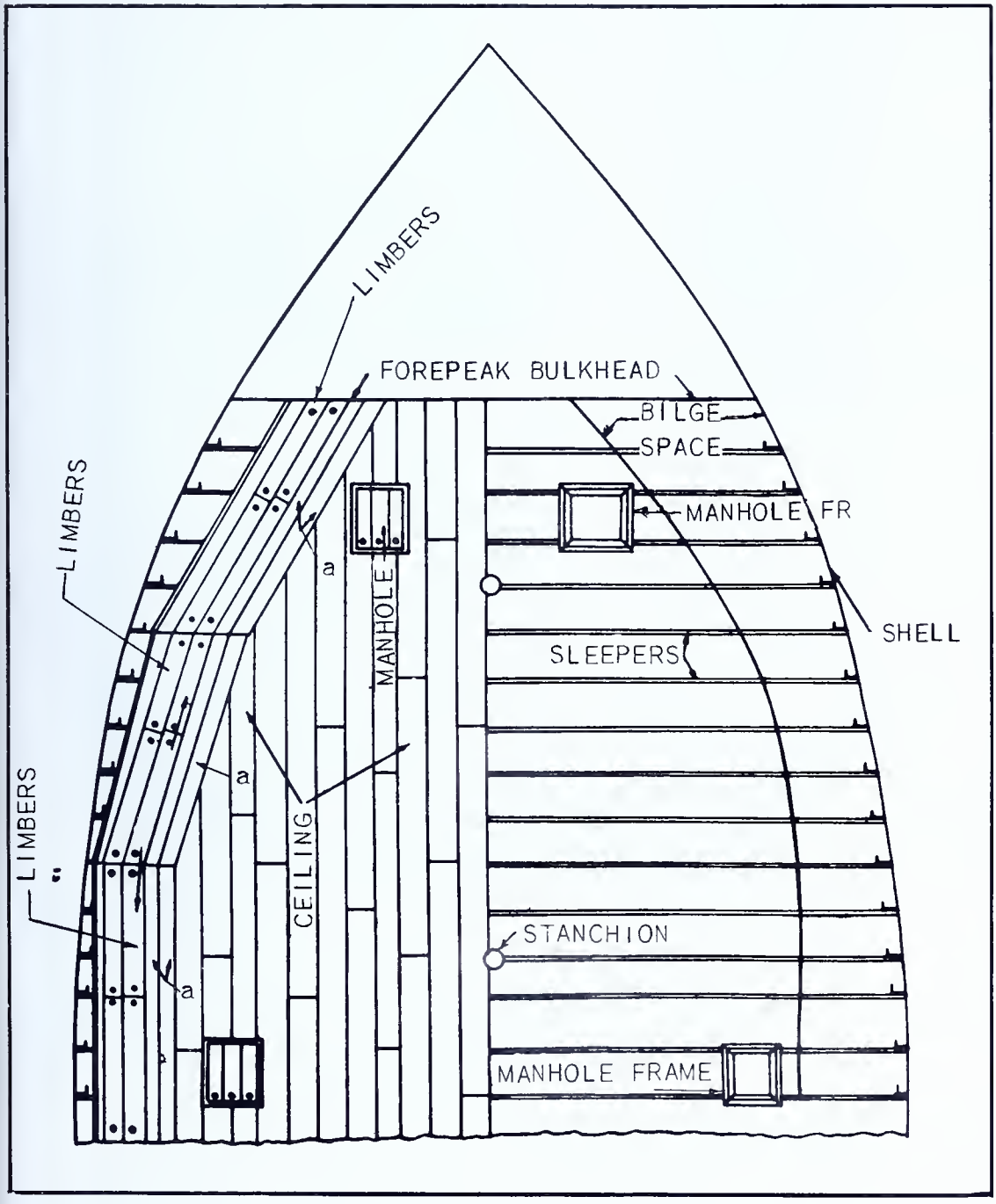


FIG. 183 — *Ceiling in Cargo Hold*

Wedge the planks tightly together as they are being laid. A tight joint between the planks prevents the cargo from seeping through the bilge and blocking the bilge pumps. When the bilge pumps are blocked, the result is the flooding of the cargo hold.

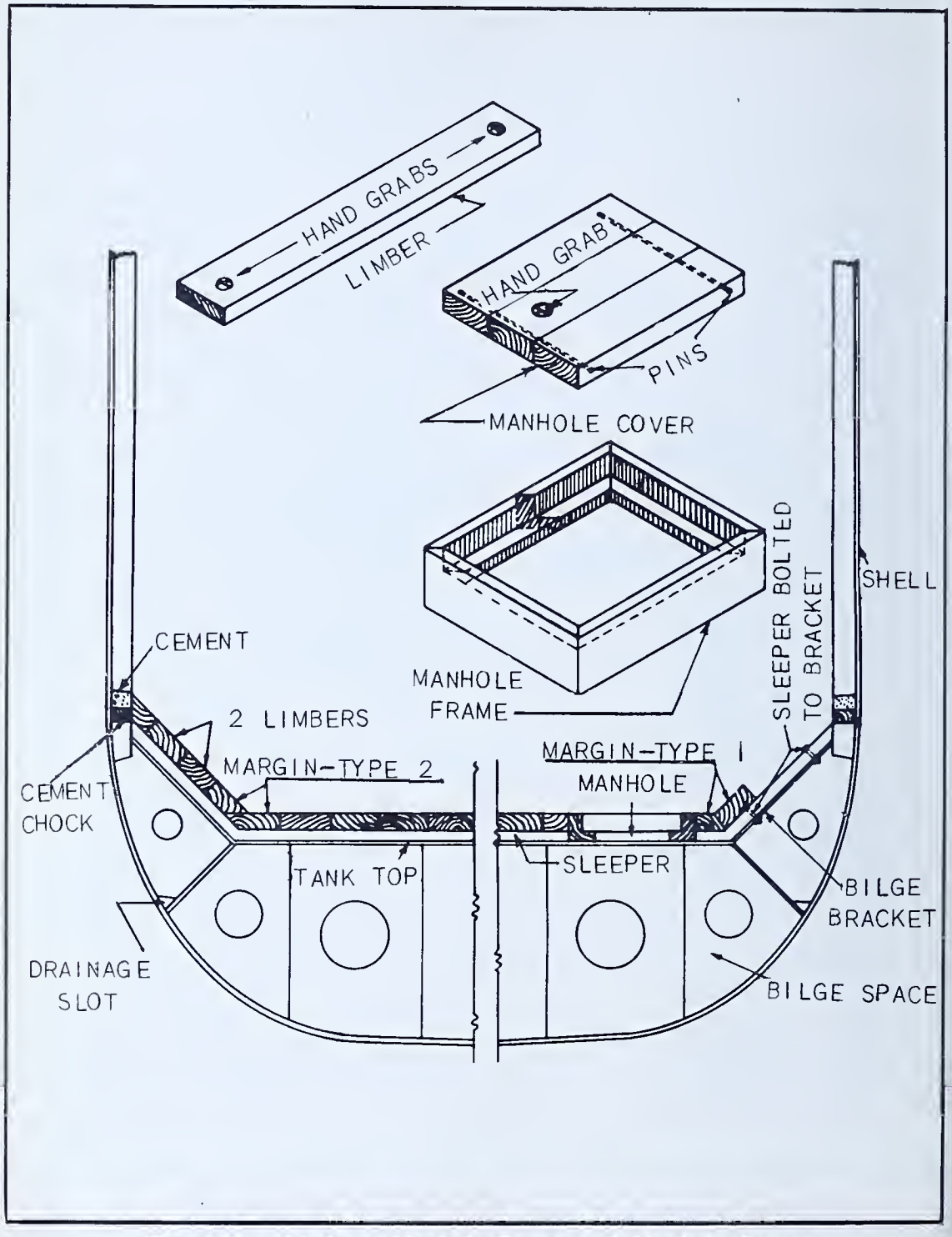


FIG. 184 — *Limbers, Manhole Frame and Manhole Cover*

When the margin planks on the tank top are spiked into position, another margin plank is placed on the bilge bracket and bolted down, or, the margin planks are spiked to a sleeper which is bolted to the bilge bracket. The next

two rows of planking on the bilge are shorter than the other planks. These short planks, called limbers, are cut to a length between eight and twelve feet. See Figs. 183 and 184. They are made portable with a hand grab in each end. The portable planks are easily removed to provide access to the bilge.

A flat piece of plank is built in between the frames at the extreme outboard edge of the bilge ceiling where the ceiling meets the frames of the ship side. This piece of plank is the foundation for cement filler which seals the shell frames and ceiling tightly, making the job grain-proof. The built-in cemented plank is known as a cement chock.

Where a tank top ceiling receives hard usage under the hatch, it is sometimes doubled to prevent wear, and the first layer of planking may be easily replaced.

Special Safety Precaution

Stand clear of the hatch opening when material is being lowered into the hold.

Tools and Materials

1. Saw
2. Hatchet
3. Square
4. Chalk line
5. Adz
6. 6′ rule
7. 40-penny wire nails

Procedure

1. See that the tank top has been inspected and painted.
2. Determine from the blueprint the size and spacing of sleepers.
3. Secure surfaced material from the shop.
4. Measure the cut sleepers to length. (measure the job)
5. Lay sleepers into position. See Fig. 185.
   Lay the bulkhead sleepers first and continue laying toward the center of the hold. The sleepers under the hatch openings may be placed slightly closer than the regular spacing because most of the wear takes place at this location.
6. Strike a fore-and-aft center line through the center of the hold.
7. Cut and lay a center strake, or plank, to the center line.
   These strakes are 3″ surfaced planks running in a fore-and-aft direction and are spiked to the sleepers with 40-penny nails.
8. Continue laying top boards on each side of the center strake until enough ceiling is laid to anchor all sleepers.

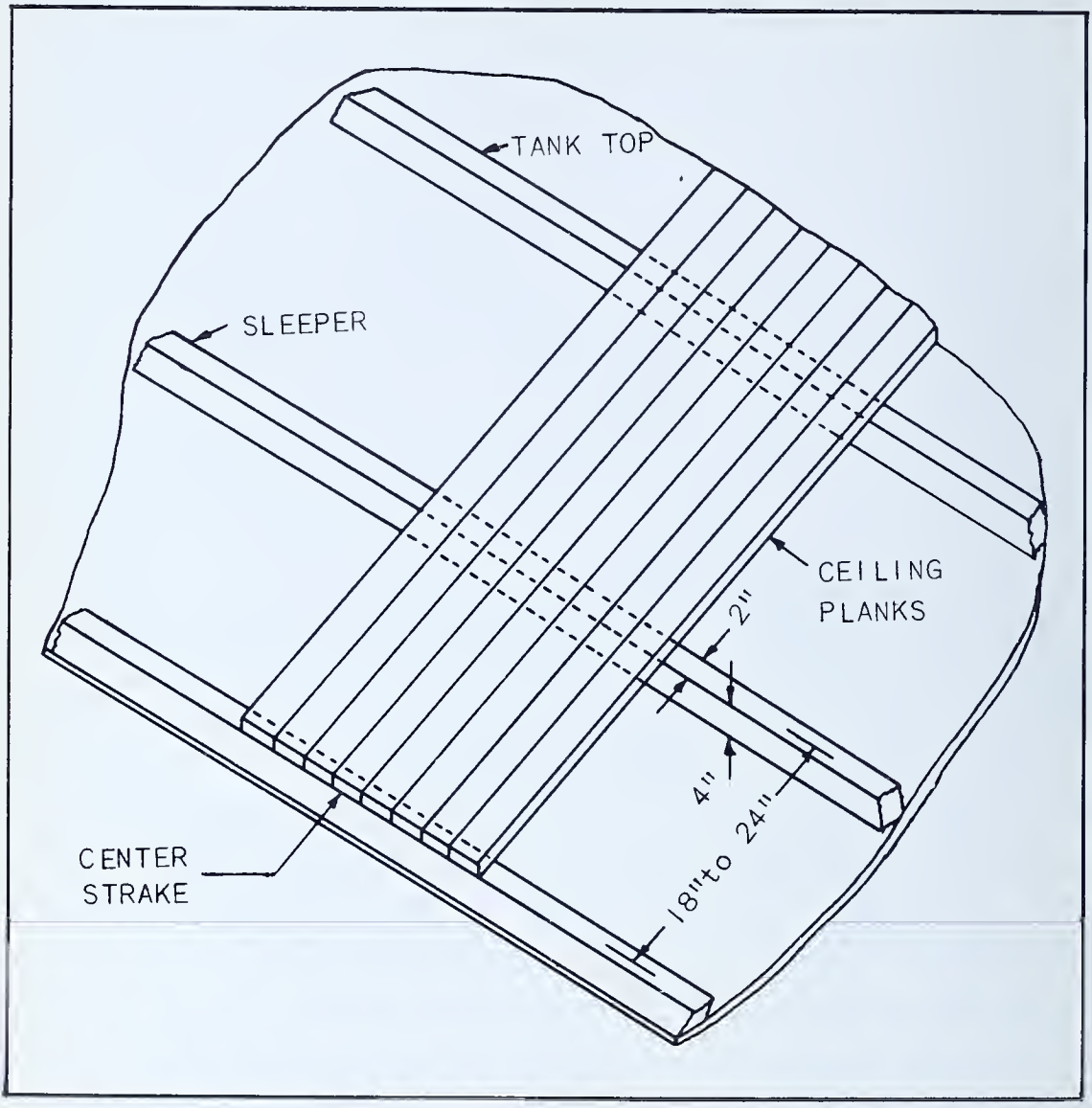


FIG. 185 — *Ceiling in Cargo Hold*

9. Place manhole covers into position over all manholes.

10. Lay margin planks along the edge of tank top where the tank top meets the bilge. See Figs. 183 and 184.

11. When all ceiling planks are in position, wedge tightly and spike to sleepers as required.

12. Lay bilge margin planks. See Fig. 183 at "a" and Fig. 184.

13. Cut and fix limbers as shown in Figs. 183 and 184.

14. Continue laying bilge ceiling until the side shell frames are reached.
15. Wedge in pieces of wood between frames to form a base for cement chocks.

QUESTIONS

1. **Why must ceiling be placed in cargo holds?**
2. **Why are sleepers sometimes placed closer together near the hatch opening?**
3. **What determines the spacing between sleepers?**
4. **Why should planks be laid on the sleepers from the center outward?**

JOB SHEET NO. 7
*BUILDING A WOODEN BULKHEAD FOR THE PROTECTION OF CARGO

General Information

Bulkheads are built into a ship to divide the ship into watertight sections. The foreward bulkhead forms a tank in the forepeak where fresh water is carried, and the after bulkhead forms another tank in the after peak where fresh water is usually carried.

The ship's carpenter sheathes these bulkheads with heavy wood to protect the cargo from damage resulting from collision with the steel bulkhead, or from absorbing moisture which condenses on the steel walls. See Fig. 186. The wooden sheathing also protects the bulkheads from damage during the loading of heavy cargo.

Safety Precautions

Use safe scaffold. Avoid climbing hazards.

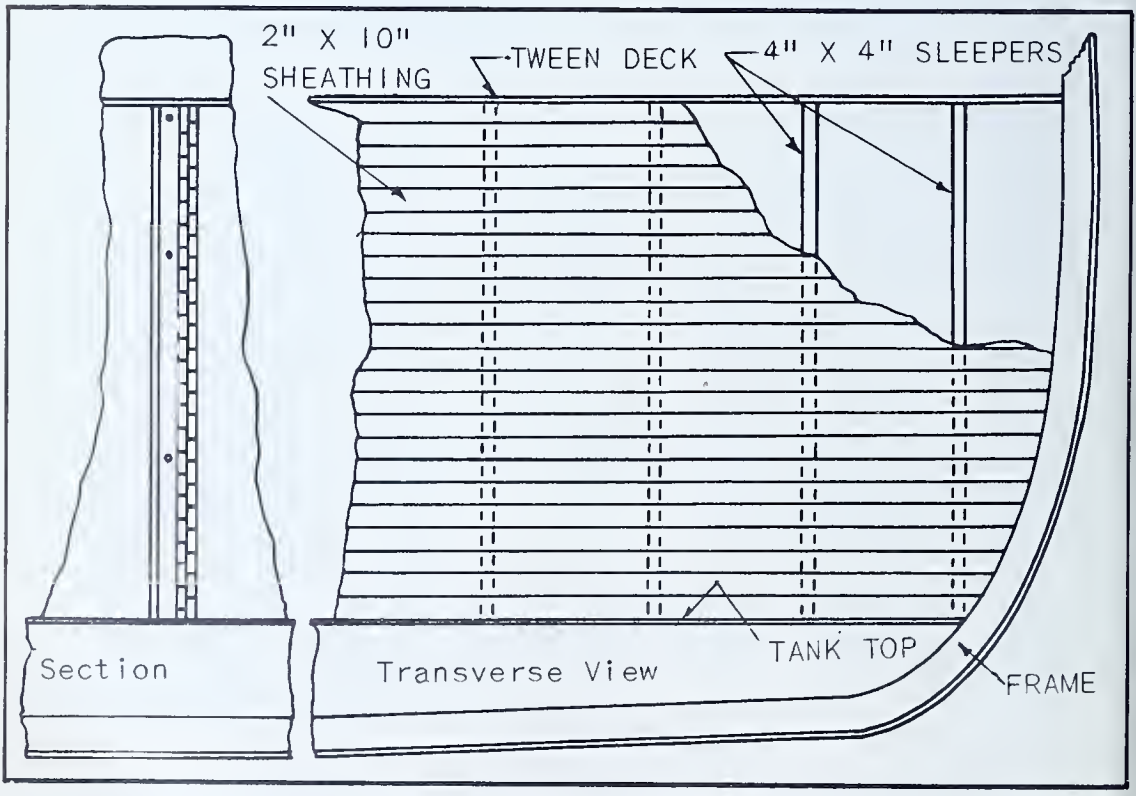


Fig. 186 — *Sheathed Bulkhead*

*Adapted from "Ship Carpentry," Alabama State Department of Education.

Tools	Materials
1. Hand saw	1½″ to 3″ thick white pine, 8″-12″ wide
2. Hammer	½″ carriage bolts long enough to bolt sleepers to clips
3. Square	40-penny wire nails
4. Chisel	Spikes
5. Mallet	4″ x 4″ pine sleepers (See the blueprint for length)
6. Bevel	
7. Brace	
8. Bits	

PROCEDURE

1. Measure the horizontal distance across the bulkhead.
2. Find the center of the bulkhead athwartship.
3. Strike a vertical line from deck to tank top, at the center of the bulkhead.
4. Strike lines at three-foot centers from vertical center line.
5. Spot positions for the clips on these lines. Center punch the location.
6. Weld on the clips. (This is a job for the welder.)
7. Bolt 4″ x 4″ sleepers to the clips.
8. Start from the bottom to apply the sheathing.
9. Cut bevels on the ends of the strips to fit the skin of the ship as the sheathing proceeds.
10. Lay grain stripping over the cracks or joints of the sheathing or use double sheathing as shown in the end view of Fig. 186.

QUESTIONS

1. **State the first step to be taken when sheathing a bulkhead.**
2. **Why are bulkheads necessary?**
3. **Why is it necessary to sheathe bulkheads?**
4. **Why is it necessary to grain-strip bulkheads?**
5. **When are the bolt holes drilled in the clips that hold the sleepers?**
6. **How are the ends of the strips made to fit the ship shell?**

JOB SHEET NO. 8
INSTALLING CARGO BATTENS, OR SWEAT BOARDS

General Information

Cargo battens, or sweat boards, are installed in the hold of a cargo ship to hold cargo away from contact with the steel body of the ship. These battens serve a dual purpose; they protect the walls of the ship from the cargo, and they protect the cargo from damage which could result from absorbing the moisture which condenses on the inside of the steel hull.

Battens may be placed in several ways. They may fit loosely in hangers; they may be screwed to metal hangers; or they may be bolted directly to the frames.

Tools

1. Handsaw
2. Square
3. Hammer
4. Plane
5. Brace
6. Bit, 9/16″
7. Adjustable wrench
8. 6′ rule
9. Saw
10. C-clamps
11. Center punch

Materials

2″ x 6″ pine
2″ x 4″ pine
20-penny nails
½″ bolts and nuts

Other Mechanics Needed: Painter, shipfitter, welder, carpenter.

Installing Battens That Fit Loosely in Hangers

On ships built with side-shell frames, or frames that run vertically, the shipfitter will weld clips on the frames to support cargo battens.

Procedure

1. Determine from the blueprint the spacing between battens.
2. Lay off the required spacings on the forward frame. (Measure from the tank top to the deck above).

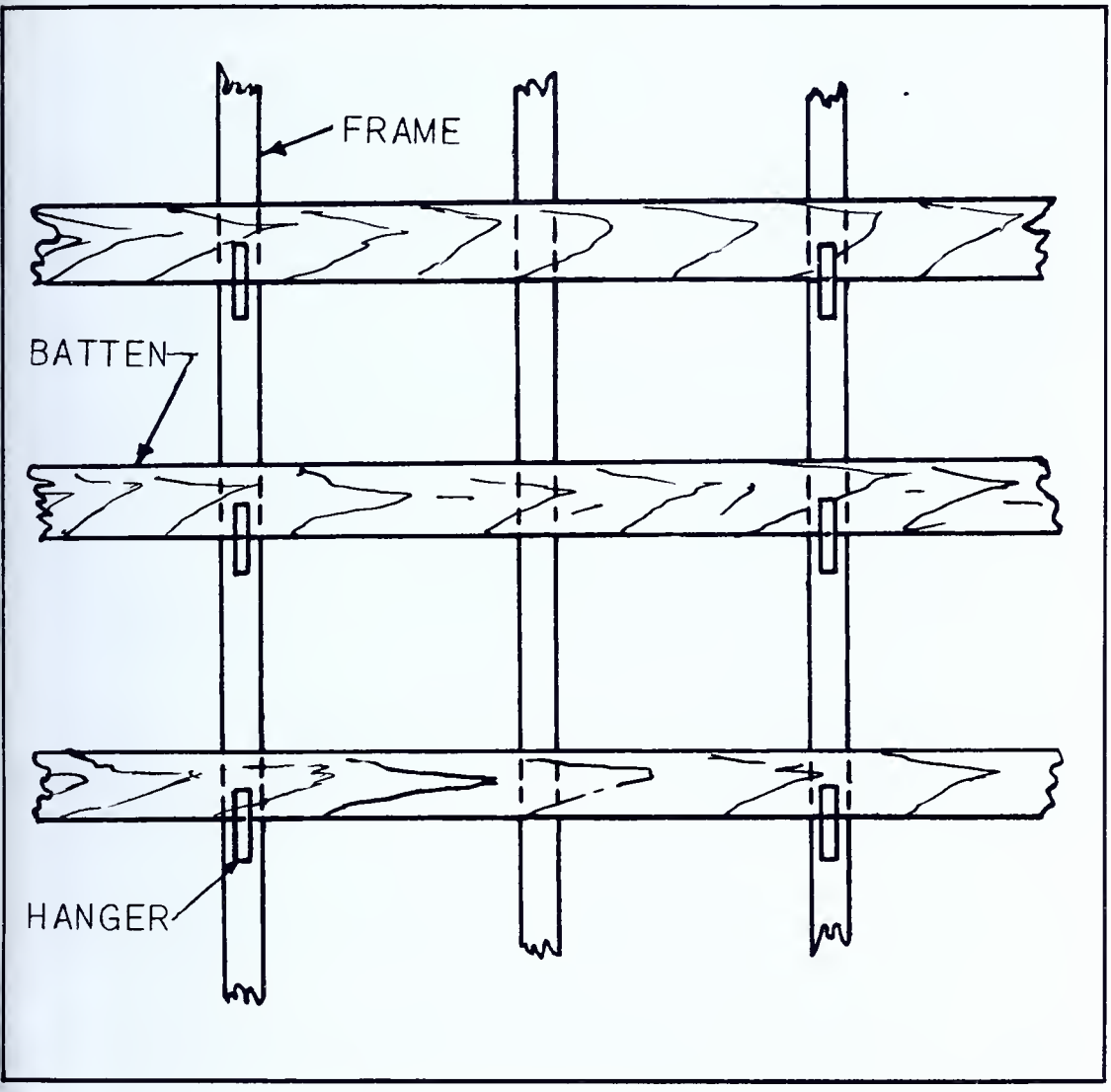


FIG. 187 — *Cargo Battens*

3. Transfer the distance by measurement to the after mark.

4. Clamp a batten board to the frames and sight the top edges to a "fair" line.

This board is clamped to the frames in line with the established marks on the forward and after frames. When the board has been placed temporarily, the top edge is sighted and moved until a "fair" line is secured. This line will follow the sheer of the ship.

5. Center punch this line on every other frame.

The purpose of center punching the line is to secure a permanent line.

6. From the established top line, measure down the required batten spacing on every other frame.

7. Center punch the above markings.
8. Have the shipfitter and welder place the batten hangers. See Fig. 187.
9. After the hangers have been placed, have the ship painted before the battens are installed.
10. Scarf 2″ x 6″ materials to fit behind battens on frames.

    On ships built with long frames the procedure is slightly different.
11. Install the batten strips.

    They may fit loosely into the hangers, or they may be screwed into place. The running joints are usually butted together without being fastened in any way.

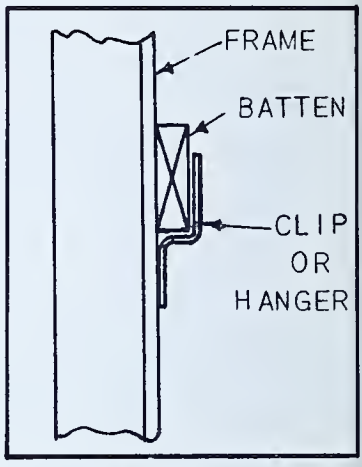


Fig. 188 — *Cargo Batten Clip*

Installing Battens That Are Nailed to Sleepers

Sleepers are first cut and bolted to longitudinal frames. The battens are then cut and nailed to the sleepers.

Procedure

1. Measure the distance along the long frames between the bulkheads.
2. Cut 2″ x 4″ sleepers to this length.
3. Drill two 9/16″ holes on 6′ centers in the longitudinal frames to which the sleepers are to be bolted.
4. Drill holes in the sleepers to match the holes in the long frames.
5. Bolt the sleepers to the long frames.
6. Measure the distance from the deck to the cement chocks.
7. Divide this distance by two.
8. Cut 2″ x 6″ battens to this half-length.
9. Beginning at deck, divide the sleepers into equal spaces 13″ on centers.
10. Fasten the lower battens (13″ centers) to sleepers with 20-penny common nails.
11. Fasten the upper battens (13″ centers) to sleepers with 20-penny common nails.

QUESTIONS

1. Explain the purpose of batten boards.
2. What is a hanger?
3. Describe the procedure which should be followed to determine the locations of hangers.
4. What is a "fair line"?
5. Why is it important that the cargo hold be painted before the batten strips are placed?
6. How are batten strips secured into position?
7. Why are vertical battens cut in two lengths?
8. Why are battens installed for easy removal?
9. How are battens removed when nailed to sleepers?

JOB SHEET NO. 9
*BUILDING PIPE CASINGS

General Information

Pipe casing is built around (or on three sides of) a pipe to protect the pipe from damage by the cargo. It is so installed that it can easily be removed for pipe inspection or pipe repairs.

Safety Precaution

Use safe staging.

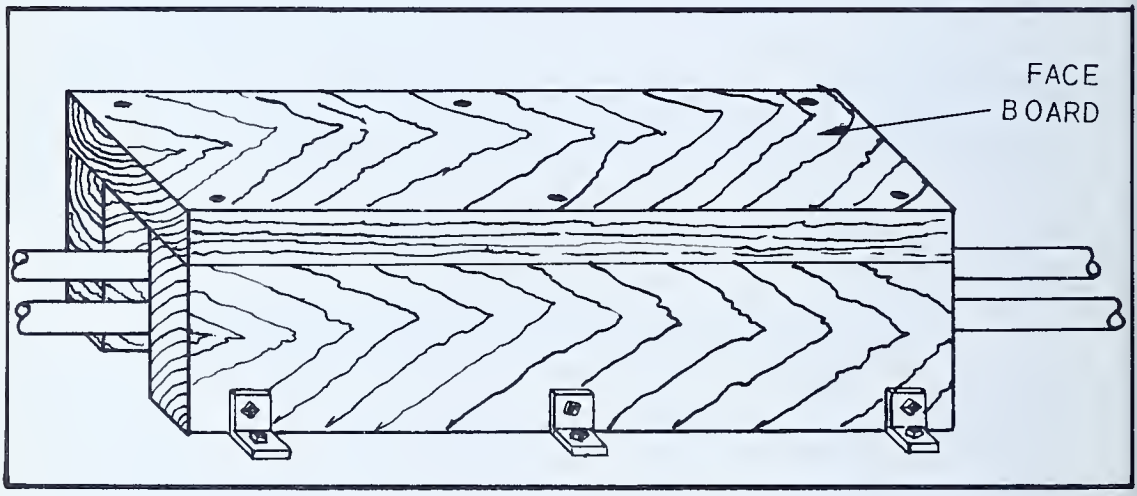


Fig. 189 — *Closed Pipe Casing*

If the pipe is laid where cargo may rest on it, the casing is built very heavy. See Fig. 189.

Pipe casings are sometimes built in an open and closed fashion like the sketch below. The pipe or pipes are well protected so that rats cannot build nests on the inside of the casing. See Fig. 190.

Tools	Materials
1. Handsaw	No. 2 or No. 3 pine
2. T-bevel	1½″ to 3″ by 6″ to 12″ fir
3. Square	8- to 40-penny nails
4. Plane	½″ carriage bolts
5. Chisel	
6. Mallet	
7. Wrench	

*Adapted from "Ship Carpentry," Alabama State Department of Education.

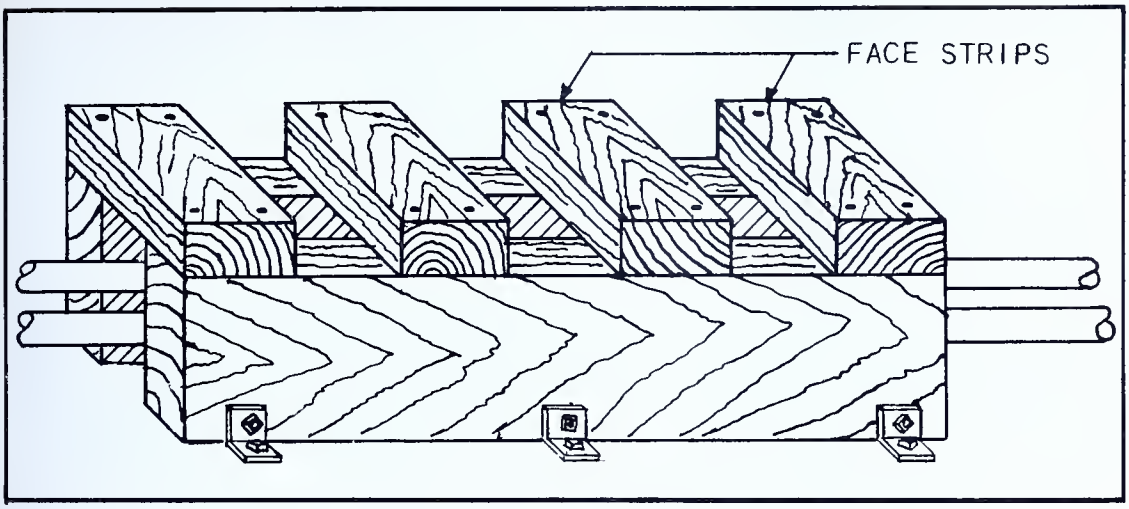


FIG. 190 — *Open Pipe Casing*

PROCEDURE

1. Select material according to the position, size, and kind of pipe.
   See the instructor at this point.
2. Measure for length and width (on the job).
3. Cut to length.
4. Dress for width. (Take to the shop if sawing is necessary).
5. Nail or bolt material to the clips on both sides of the pipe.
   Clips are installed by the shipfitter. See Figs. 189 and 190.
6. Nail or screw on face board.
7. Bevel corners with plane.

QUESTIONS

1. **Why is it necessary to use heavy material for pipe casing?**
2. **Why are overhead pipes cased in?**
3. **What is meant by an "open pipe casing"?**
4. **Give the reason for "open pipe casing".**
5. **Who decides what material to use for pipe casing?**

JOB SHEET NO. 10
*MAKING HATCH COVERS

General Information

'Tween-deck hatches serve as a covering over the lower hold. After the cargo is loaded into the lower hold, these hatches are put into place and then the 'tween deck is loaded. The main-deck hatches cover the cargo hatch. After they are put in place, three or four pieces of tarpaulin are spread over them and battened down.

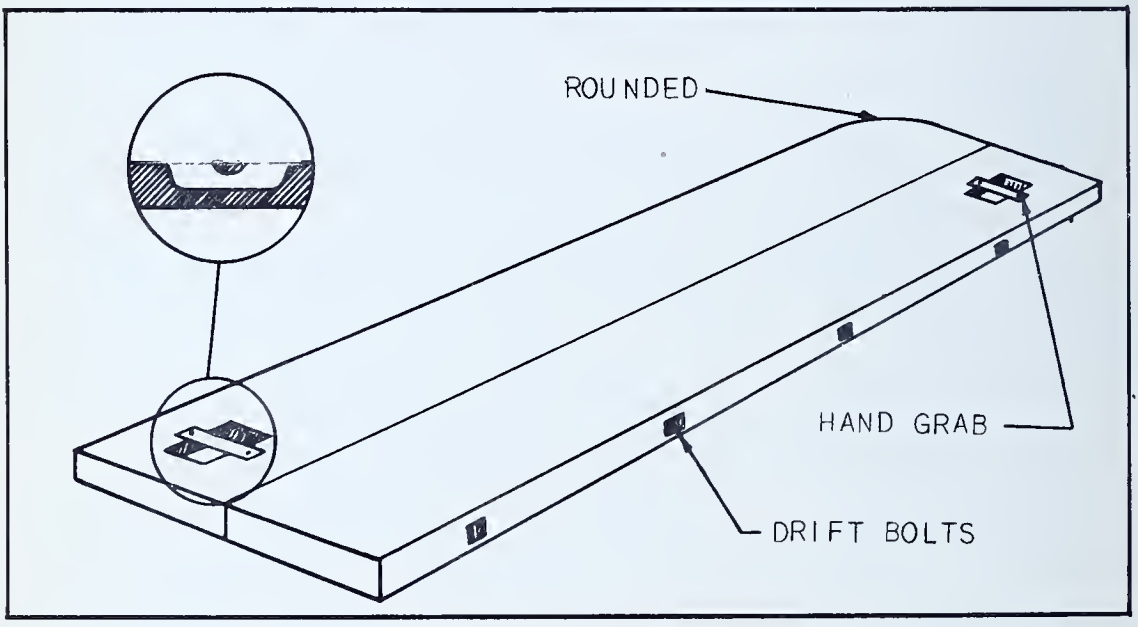


Fig. 191 — *Double Hatch Cover With Drift Bolts*

Tools	Materials
1. Hammer	3″ x 12″ x 10′-0″ pine, spruce, fir
2. Saw	⅝″ x 18″ drift bolts
3. Chisel	Steel handholds
4. Mallet	Screws
5. Brace	
6. Bit	

Procedure

1. Measure for the length of the hatch.
2. Cut material to length.
3. Clamp two pieces of material together as shown in Fig. 191.

*Adapted from "Ship Carpentry," Alabama State Department of Education.

4. Space off for the drift bolts.
5. Bore holes for the drift bolts with a 9/16″ bit.
6. Set drift bolt.
7. Oil the drift bolt so as not to split wood.
8. Drive drift bolt down hard.
9. Round off one corner of the hatch cover. See Fig. 191 for corner covers only.
10. Measure about 10″ in for handholds.

    In two-board hatches the handholds are placed in opposite ends of the boards. See Fig. 191.
11. Cut handholes.
12. Screw on steel handholds.
13. Drop hatches into place.
14. Fig. 192 shows a single hatch cover without drift bolts.

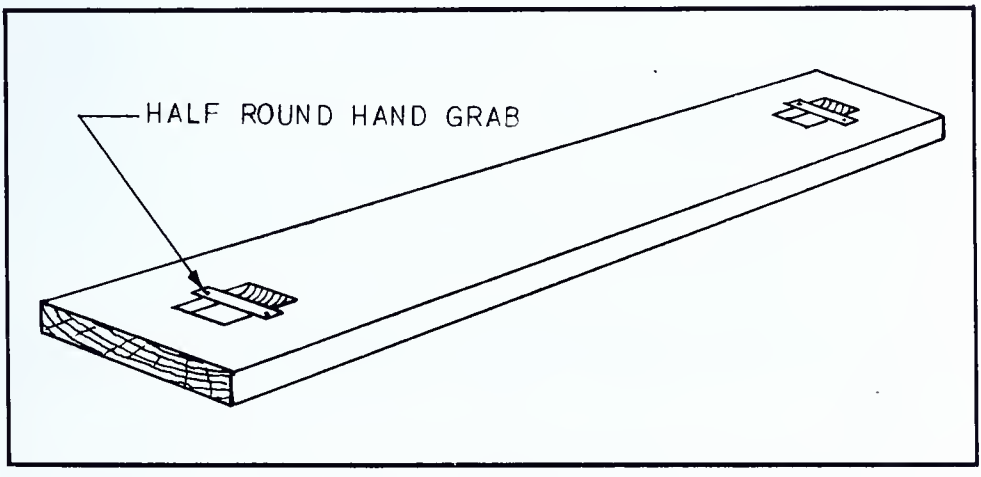


FIG. 192 — *Single Hatch Cover*

QUESTIONS

1. **Why are hatches made in two pieces?**
2. **Why is a No. 1 grade of material never used in a hatch cover?**

JOB SHEET NO. 11
*LAGGING A SHAFT ALLEY COVER

General Information

Lagging is the heavy wood strips which cover the shaft alley to protect the steel plates. All ships do not have the shaft alley lagged. The size of the timbers used will depend on the kind of cargo that the ship carries.

Tools

1. Ax
2. Adz
3. Bevel
4. Brace
5. Bits
6. Chisel
7. Dividers
8. Handsaw
9. Mallet

Materials

3″ x 8″ pine
Band iron
Template wood

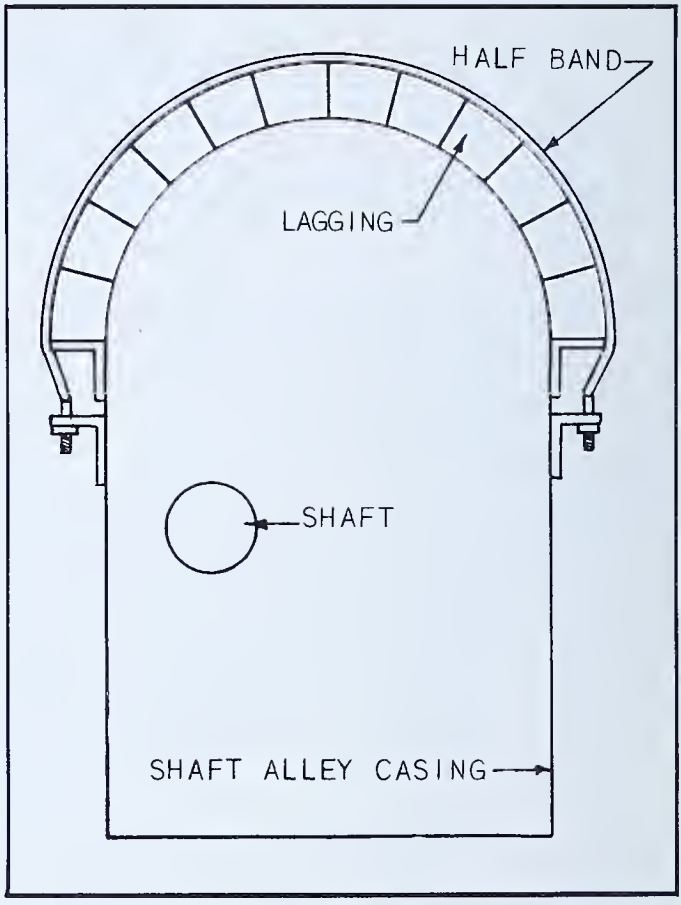


Fig. 193 — *Lagging Fitted to Shaft Alley Arch*

Safety Precautions

Watch for materials being lowered from overhead. Keep adz sharp.

Procedure

1. Lay out the template to the shape of the top of the shaft alley.
2. Cut the template to the shape of the layout.
3. Divide the template into equal spaces with the dividers. See Fig. 194.
4. Saw out a mold using one division of the template for a pattern. See Fig. 194.
5. Mark the ends of 3″ x 8″ lagging with mold to get the bevels.

*Adapted from "Ship Carpentry," Alabama State Department of Education.

6. Cut the bevels on the lagging with the band saw, or run through the shaper.
7. Fit the materials on the shaft alley. See Fig. 193.
8. Clamp the material to the shaft alley with a half-band iron.

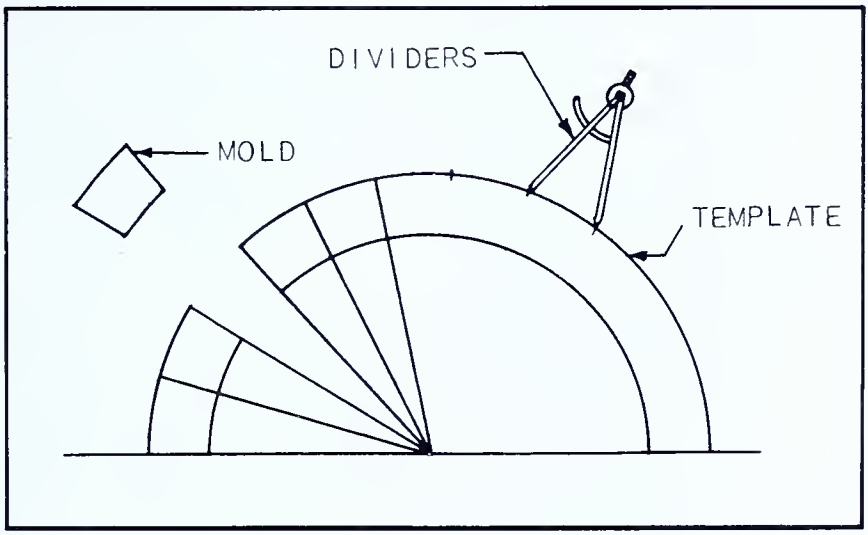


FIG. 194 — *Preparing the Template for Shaft Alley Lagging*

The shipfitter furnishes the half-band.

Clips are already in place on the shaft alley to bolt band iron.

9. Trim up lagging with adz and plane.

QUESTIONS

1. **Why is a template used?**
2. **Explain the method of laying out the template for shaft alley lagging.**
3. **How does the mold speed up the laying of the material?**
4. **How is the bevel cut on the shaft alley lagging strips?**
5. **Who furnishes the clips and band iron for securing the lagging to the shaft alley?**

JOB SHEET NO. 12
*INSTALLING INSULATION IN AN ICEBOX, SIDES AND OVERHEAD OF HOLD

General Information

A ship's icebox is usually built inside a room under the shelter deck. This room on a steel ship has steel sides. The icebox is usually divided into two rooms, a cool room and a cold room. See Fig. 195. The icebox is placed as near the galley as possible. The carpenter does all the work on the box with the exception of the final floor and cooling coils. The size of framing used is determined by the thickness of the insulation called for in the specifications. This insulation will usually be about 9″. The insulating material is blown in behind the ceiling because this method will pack the insulation much harder than it can be packed by hand.

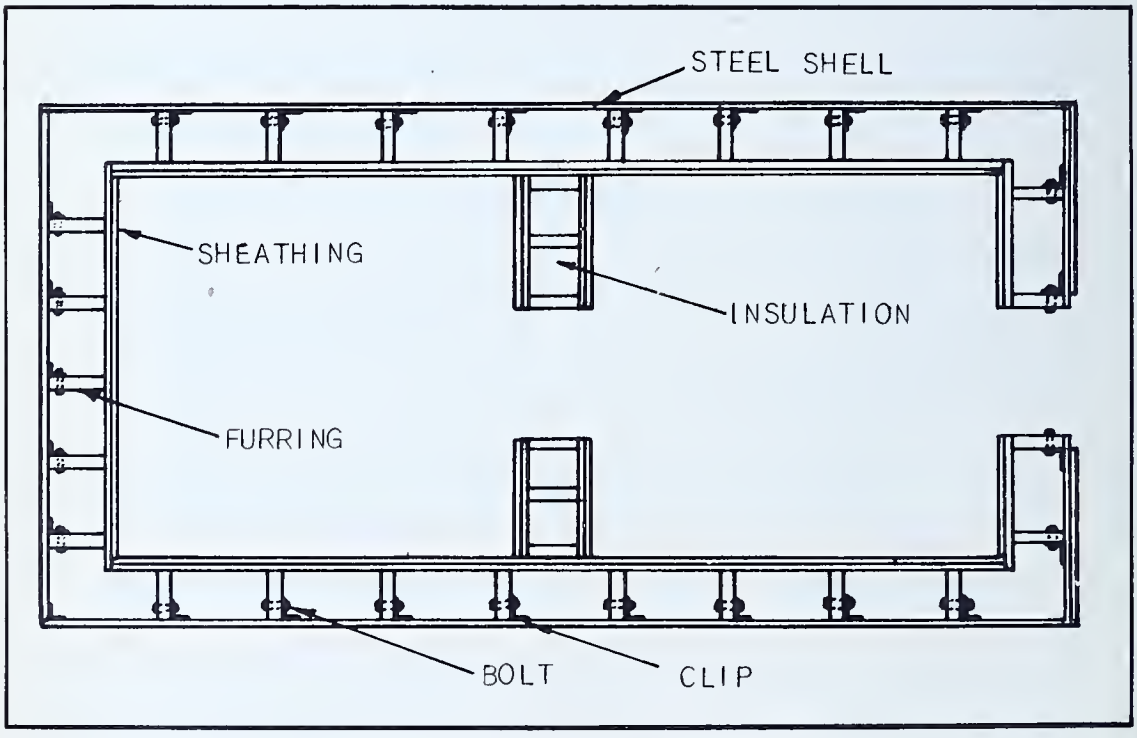


Fig. 195 — *Plan of Ship's Icebox*

Insulation is installed in the holds of those ships that carry perishable cargoes. The installation of insulation calls for a highly skilled workman since all joints and fits must be as near air tight as possible.

*Adapted from "Ship Carpentry," Alabama State Department of Education.

Safety Precautions

Safeguard eyes when working overhead. Keep trash from underfoot.

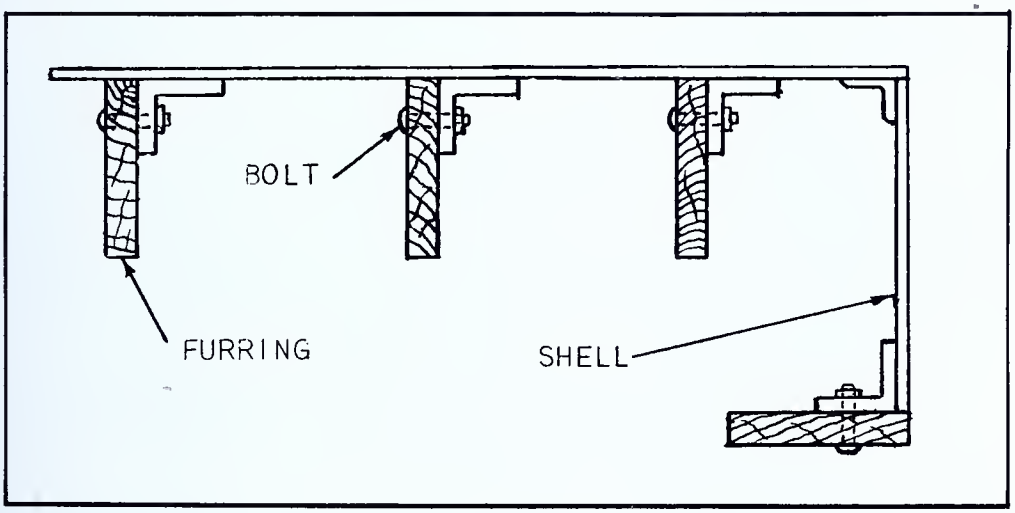


Fig. 196 — *Furring Bolted to Angles*

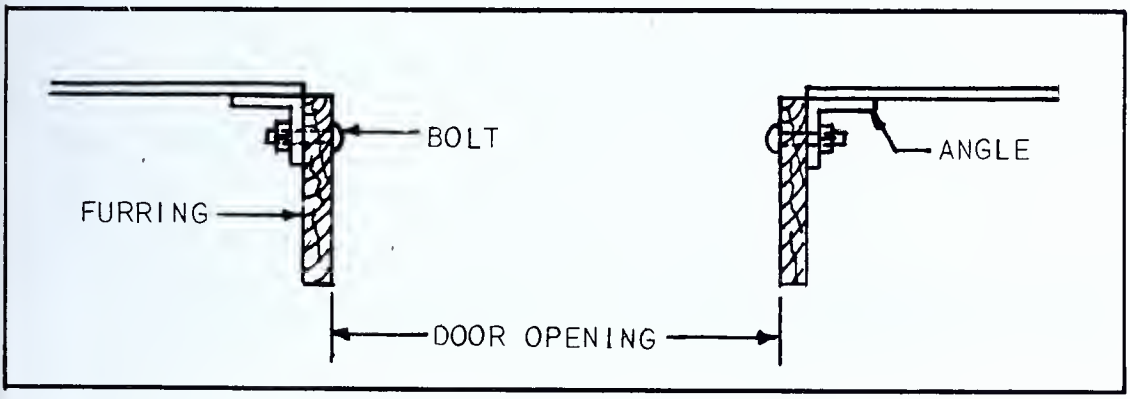


Fig. 197 — *Furring for Door Opening*

Tools	Materials
Saw	2″ x 9″ x 8′ yellow pine sleepers or furring
Hammer	1″ x 6″ ceiling
Square	2″ x 2″ pine sleepers
Bevel	6- and 8-penny common galvanized nails
Chisel	½″ x 2½″ galvanized carriage bolts
Mallet	Sheet cork
Brace	Granulated cork
Bits	Hair
Expansive bit	Bitumastic compound
	Screen wire
	Galvanized tacks

PROCEDURE

1. Clean and paint all steel that is to be covered.
2. Measure distance between decks where the icebox is to be built.
3. Cut 2″ x 9″ furring to this measurement.

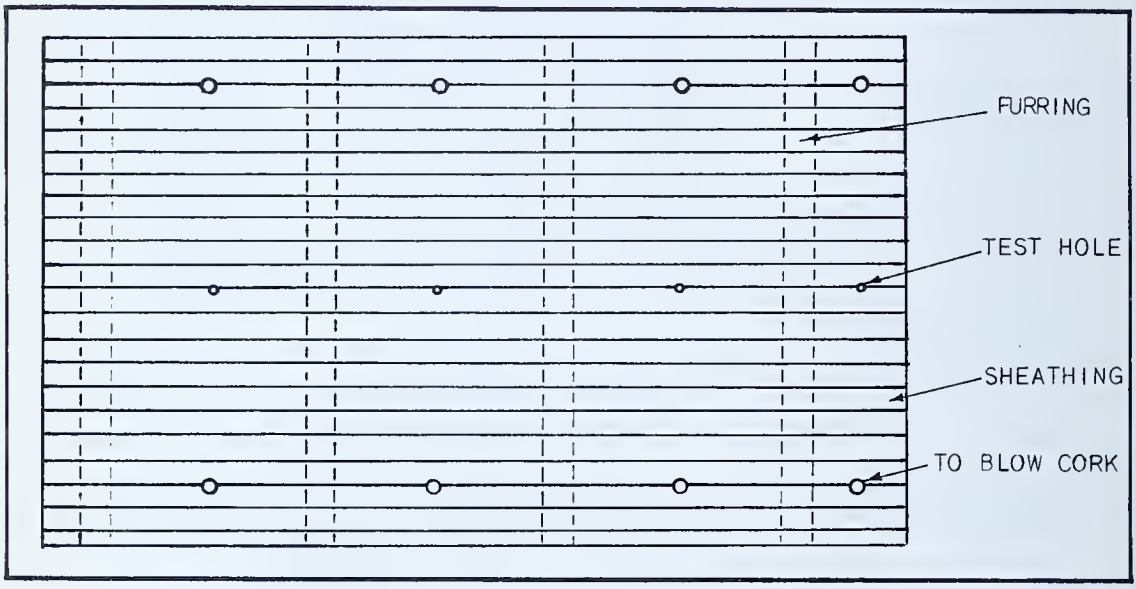


FIG. 198 — *Holes for Cork, and Test Holes, in First Layer of Sheathing*

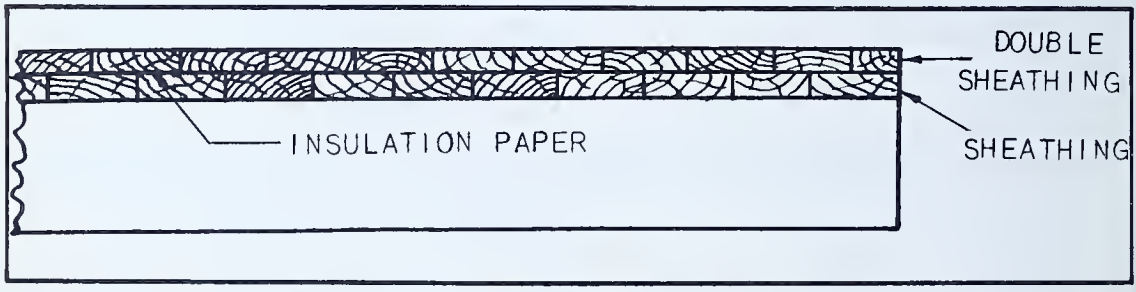


FIG. 199 — *Insulation Between First and Second Sheathing*

4. Mark the furring for bolt holes.

   The steel framework inside the room should have holes already drilled, or in case of a smooth inside wall, clips will be welded in place to bolt the furring in place.

5. Bore 9/16″ holes in 2″ x 9″ furring.
6. Bolt furring in place. See Fig. 196.
7. Measure across the length and the width of the top of the icebox.
8. Cut top pieces of furring to length.

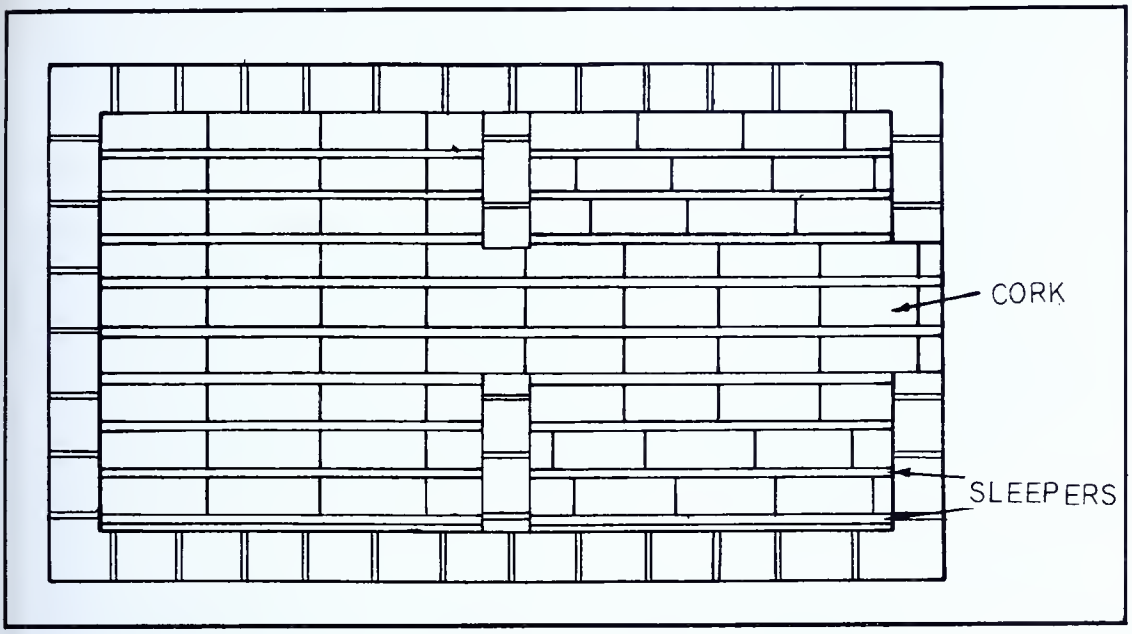


FIG. 200 — *Cork Floor*

9. Bore holes and bolt the pieces to the deck beams.
   Bolt the pieces in the direction that the deck beams run.
10. Measure the size of opening for the door, and cut 2″ x 9″ furring to frame the door.
11. Bolt the furring to the door opening. See Fig. 197.
12. Cut the ceiling to length for the top of the box.
13. Start the ceiling on a straight side and lay it overhead all the way across.
    In case of pipes between the deck beams or frames, the ceiling should be fastened in with galvanized wood screws for easy removal in case of repairs to the pipes.
14. Ceil the side walls up about four feet starting from the bottom.
15. Pour in granulated cork and pack the cork down until it is level with the top of the ceiling.
16. Ceil on up and add cork until one board from the top is reached.
17. Pack with hair the space that the last piece of ceiling will cover.
18. Put on last piece of ceiling.
    This procedure is the same on all four walls.
19. Bore a 4″ hole at each end of the top and bottom ceiling between each frame, and a test hole about 1″ in diameter in the middle. See Fig. 198.
20. Blow cork in each 4″ hole until it is packed tight and can be seen through the test hole.

21. Stuff holes with hair and tack a small piece of screen wire over each hole.
    Follow this procedure between each frame. Lay insulating paper over the first layer of ceiling. Fig. 199.
22. Cut a second layer of ceiling to the length of the top.
23. Rip a piece of ceiling in half.
    This will give a piece of ceiling 3″ wide. This 3″ piece is put up first, and as the rest of the ceiling is 6″ wide, the second layer will break the joints of the first layer. See Fig. 199.
24. Ceil the side walls the same way.
25. Determine position of the partition of the icebox. (See blueprint).
26. Cut 2″ x 9″ to the length of the width of the box.
27. Lay a 2″ x 9″ on steel floor where the partition will be and toenail it to the sides.
28. Cut 2″ x 9″ to length and nail it to ceiling overhead, directly over the 2″ x 9″ on the floor.
29. Measure the distance between the 2″ x 9″ on the floor and the 2″ x 9″ on the ceiling.
30. Cut 2″ x 9″ studs to this length.
31. Locate the position of the partition door and space the 2″ x 9″ studs to 2-foot centers on both sides of the door opening.
32. Ceil and insulate the same way as the sides and the overhead.
33. Lay two rows of 2″ x 12″ x 30″ cork on the floor, hard against the side and the ends of the box. See Fig. 200.
34. Lay a 2″ x 2″ pine sleeper the length of the distance between the walls against the cork.
35. Lay a second layer of cork and 2″ x 2″ sleeper.
36. Continue this procedure until the floor is covered.
37. Give the cork and the sleepers a heavy coat of bitumastic compound.
38. Lay a second layer of cork, sleepers, and bitumastic compound over the first layer.

QUESTIONS

1. **Where is the icebox located aboard ship?**
2. **Why is the ceiling put on double with the seams lapped?**
3. **State the reason for a test hole being cut in the bottom of the ceiling before the cork is blown in the larger hole.**
4. **What is the purpose of insulation paper?**
5. **Explain the purpose of the screen wire over the test holes.**

JOB SHEET NO. 13
INSTALLING CABLE CARRIER COVERS

General Information

A cable carrier is built for the purpose of carrying electric cables (power lines) to various parts of the ship. The cable carrier is a trough running in a fore-and-aft direction from the engine room to points forward such as the pumprooms, midship house, and forepeak. On tankers, the cable carrier follows the fore-and-aft gangway and is welded to it by the shipfitters.

The cable carrier is built of steel channel with a canvas-covered wood slab fastened to the channel with steel plates, U-bolts, and nuts. See Fig. 201.

The steel channel is the base and body of the carrier. The wood is covered with canvas to make it watertight and it forms a cover for the channel trough. The U- bolts go around the channel and through holes in the wood cover. A

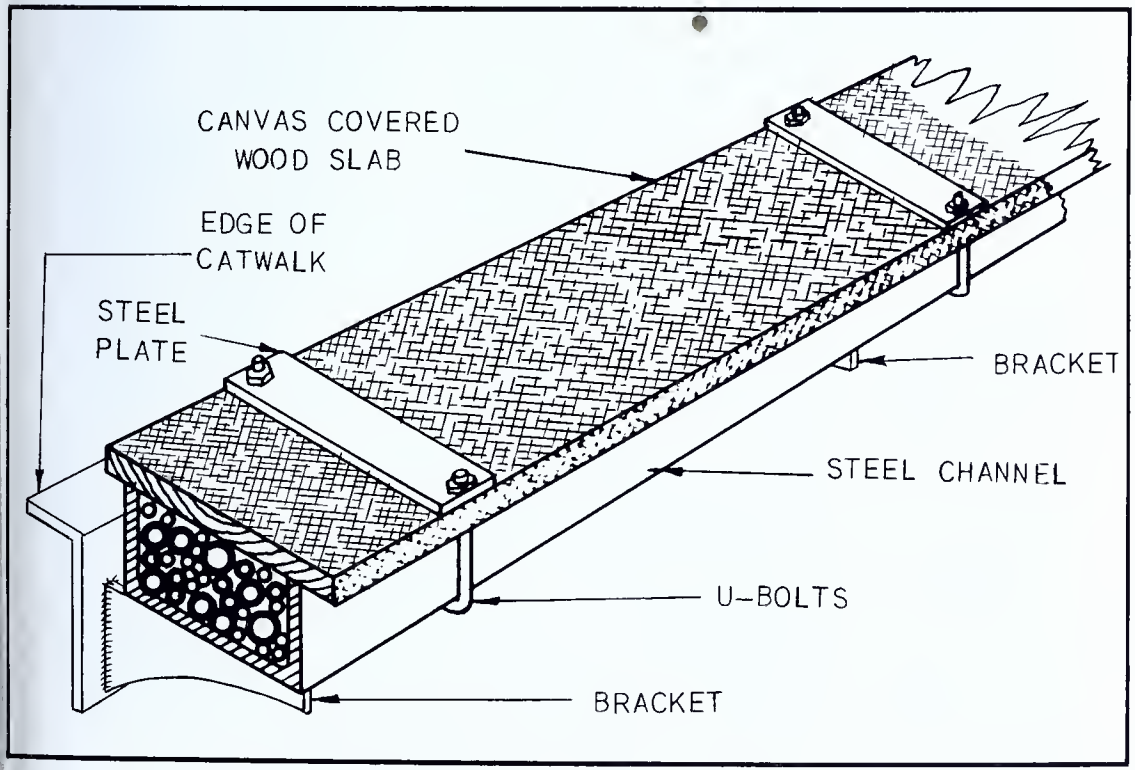


Fig. 201 — *Cable Carrier Cover*

steel plate is placed over the U-bolt and it is tightened down by nuts on each end of the U-bolt. The entire assembly forms a strong, watertight tunnel to protect the electric cables from damage and from water.

PROCEDURE

1. Determine from the blueprint the length of stock required.
2. Obtain dressed stock for the cover from the shop.
3. Cut the cover to the length shown on the blueprint.
4. Cover the wood with canvas. (Use flat head galvanized tacks).
5. Determine from the blueprint the location of the holes for the U-bolts.
6. Obtain the U-bolts and steel plates from stores.
7. Install the cover as shown in Fig. 201.

QUESTIONS

1. **Explain how the canvas is fastened to the wooden cover.**
2. **Outline the procedure for locating the holes for the U-bolts.**
3. **How is the spacing for the steel straps obtained?**

JOB SHEET NO. 14
MAKING SPARS

FIG. 202 — *Working a Spar to Shape*

General Information

Spars are rounded timbers on a ship, such as masts, yard arms, boom signal yards, and etc. Spars may be built for various needs. Each spar may require a different shape, length, or width, according to the purpose for which it is to be used. See Fig. 202.

There are two well established rules used for years by spar builders, and they are considered the most accurate and the easiest applied rules known.

The first rule is the Eight-Square table as shown in Fig. 203, and the second is the Sixteen-Square table. Both rules and layouts are shown in Fig. 206.

The timber to be used for a spar should be heart wood if possible. Heart wood is the center of a tree, and if a spar is built of this kind of timber, it will seldom warp or twist. The timber should be of a perfect grade, free from knots, heart shakes, wind shakes, and sapwood.

Tools and Materials

1. Rule
2. Level
3. Adz
4. Ax
5. Draw knife
6. Chalk line
7. Plane
8. Square
9. Saw
10. Yellow pine or fir timber 8″ x 8″ x 48′-0″

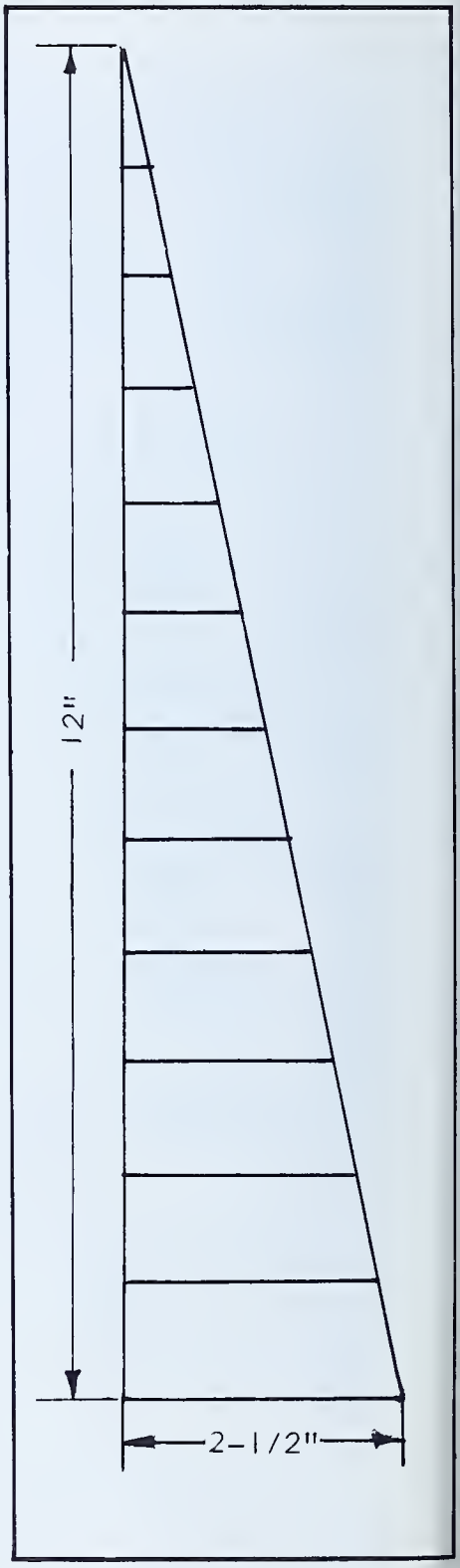


Fig. 203 — *Eight-Square Table*

PROCEDURE

1. Select suitable material. See Fig. 204.
   (a) Free from knots.
   (b) Free from wind shakes.
   (c) Free from heart shakes.
2. Place the stock level at a suitable working height.

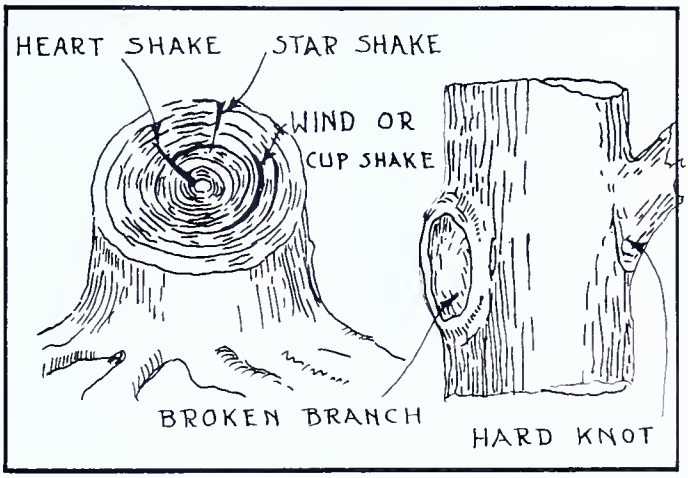


FIG. 204 — *Causes of Poor Material*

3. Measure and cut stock to length.
4. Strike vertical and horizontal center lines.
5. With a chalkline strike center lines the full length of the stick on all four sides. See Fig. 205.

   All preliminary measuring and cutting must be done from these center lines, so that the spar will be round and straight.
6. Consult the drawing for the length and swell of the spar.

   Swell lines indicate increase or decrease in the diameter of the spar.
7. Mark off the various lengths between the given swell diameters.
8. Lay off swell diameters as given on the blueprint, measuring half the diameter on each side of the center line.
9. Snap a chalk line through the swell points which will give the shape of the spar. See Fig. 207.

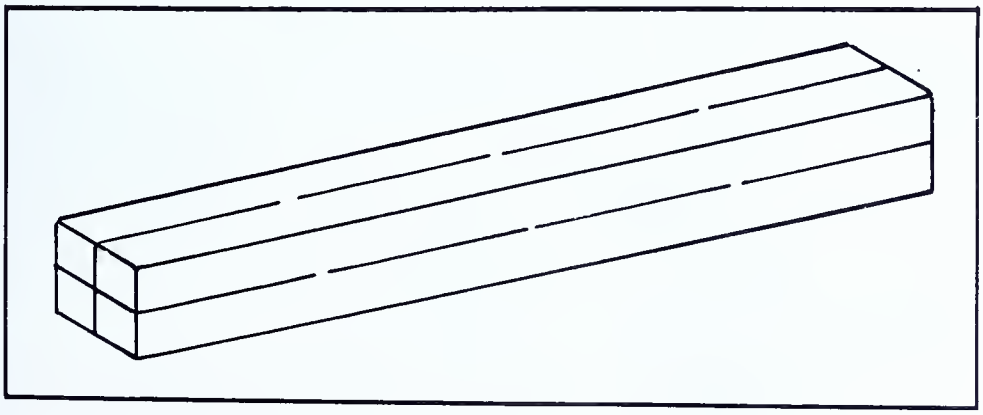
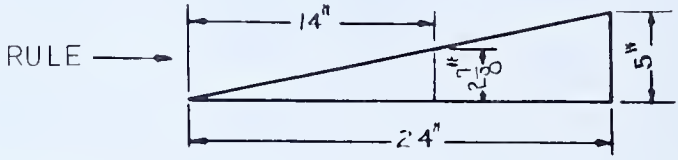
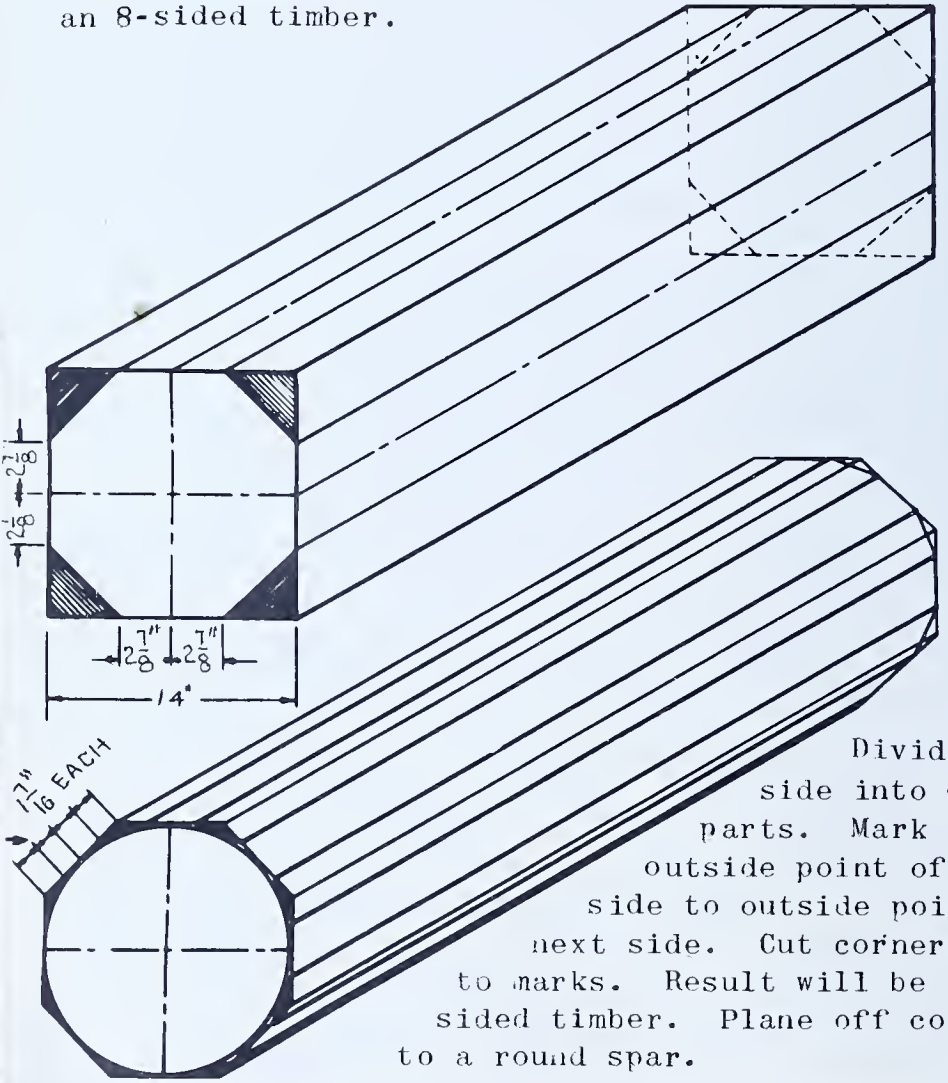


FIG. 205 — *Center Lines on Rough Timber*

METHOD USED TO 8-SIDE OR 16-SIDE
A TIMBER FOR A SPAR



Mark off 2-7/8" on each side of C of timber. Cut corners of timber to these marks. Result will be an 8-sided timber.



Divide each side into 4 equal parts. Mark from outside point of one side to outside point of next side. Cut corners off to marks. Result will be a 16 sided timber. Plane off corners to a round spar.

FIG. 206 — *Eight-Square and Sixteen-Square Table*

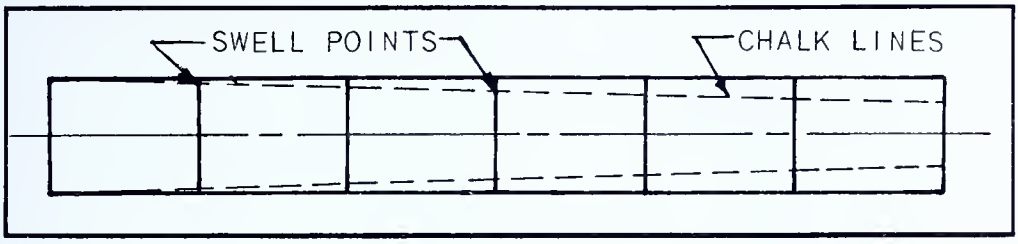


FIG. 207 — *Swell Line Layout*

10. Work the timber to these lines with an ax, adz, crosscut saw, and finally plane smooth.

    If the spar is cut below or deeper than a flat surface between these lines it will be ruined.

11. Turn the stick on all sides and repeat operations until all four sides are cut. The stick is now in a square, tapering shape, as shown in Fig. 208.

12. The stick is now ready to be laid out for the *eight-square* lines. Consult the eight-square scale or table in Fig. 203. The scale is laid out with numbers from 0″ to 12″; some scales run to 24″. Measure the distance across the stick at "a", Fig. 209. Assume that at this point the timber measures 6″. Measure the distance across the scale at the 6″ mark and you will find that the measurement is 1¼″.

    With a pair of dividers set at 1¼″, mark 1¼″ on each side of the center line on the timber at "a", Fig. 209.

    Now measure the distance across the timber at "b", Fig. 209. Assume that the measurement at this point is 5″. Measure the distance across the scale (Fig. 203), at the 5″ mark, and it will be found that this measurement is 1-1/16″. Set dividers at 1-1/16″ and mark the spot on line "b"

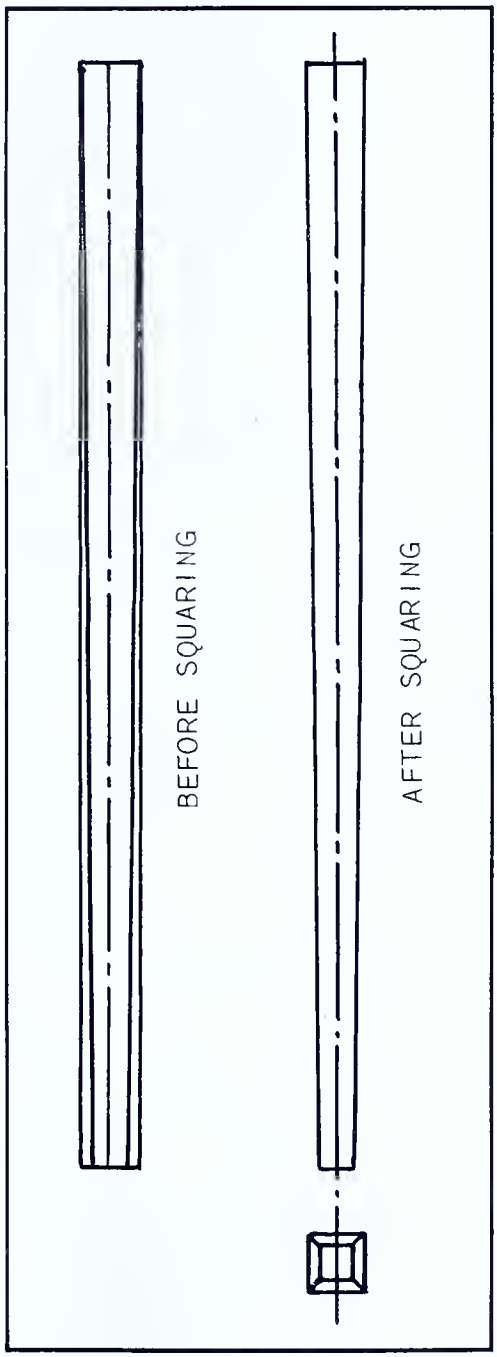


FIG. 208 — *Squared Spar*

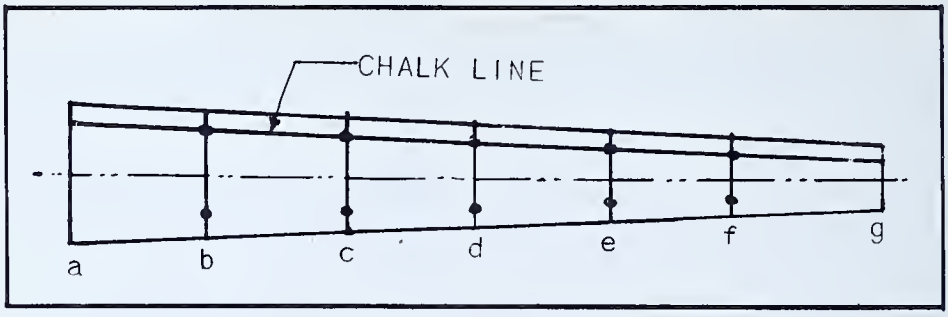


FIG. 209 — *Eight-Square Layout*

on each side of the center line of the timber. Continue in this manner until the stick has been measured at "c", "d", "e", "f", and "g", and the corresponding measurements taken from the eight-square table and transferred to the stick. Connect these spots with a chalk line mark as shown in Fig. 209.

This same layout will have to be followed on the four sides of the timber. When the wood is cut away between marks, the stick will look like the end of the center view of Fig. 206.

13. For sixteen-square, divide distance between the eight-square lines in quarters as shown in Fig. 210. Another view is shown in the lower half of Fig. 206.

14. Step one quarter to each side of the center line on each flat.

15. Strike chalk lines between these points.

16. Cut off each sixteenth corner between lines with adz and smooth with a plane.

17. The stick now has sixteen sides and should be rounded with a draw knife and radius plane until a true radius has been obtained.

A radius plane is an ordinary wood plane shaped to a desired radius. A plane of this type has been found to be very useful in finishing a spar.

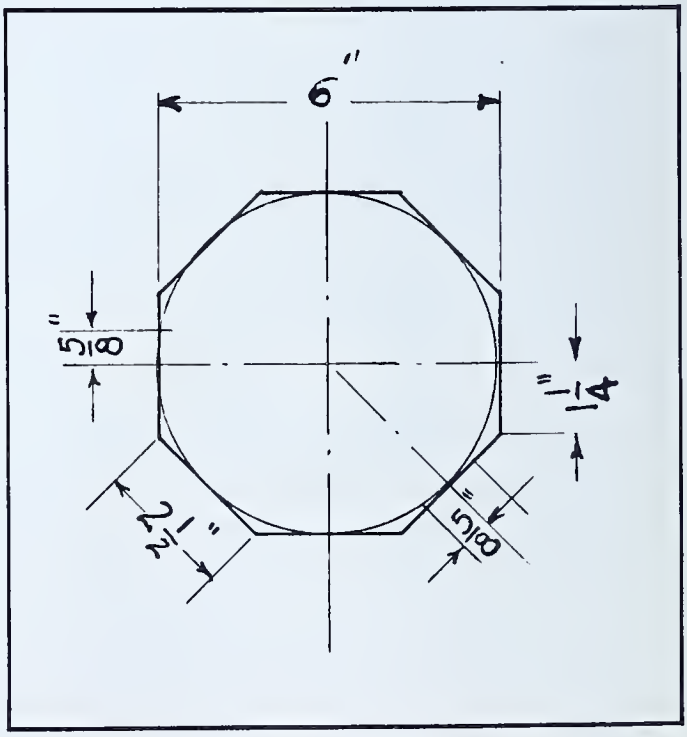


FIG. 210 — *Layout for Sixteen-Square*

18. Use sandpaper for the final finish.

19. Have spar varnished to eliminate weather cracks.
(Fitting bands to a spar will be shown in another lesson.)

QUESTIONS

1. **What are spars?**
2. **What is heart wood?**
3. **What is meant by the swell of a spar?**
4. **How is a spar cut to a squared shape?**
5. **Explain the eight-square rule.**
6. **What tools should be used for eight-squaring?**
7. **What happens if cut too deep?**
8. **Define the sixteen-square rule.**
9. **What is the use of a radius plane?**
10. **Why should a spar be varnished?**

JOB SHEET NO. 15
*CUTTING STEPS IN SPARS

General Information

The step is cut on the heel of the mast or spar to secure the mast in place and to keep it from turning. (Fig. 211). Two types of steps are shown. Care must be taken while cutting this step to give the proper "rake" to the mast.

Safety Precaution

Beware of injuries from edged tools on this job.

Tools

1. Crosscut saw
2. Square
3. Bevel
4. Chisel
5. Mallet
6. Adz

Materials

1″ x 3″ batten material

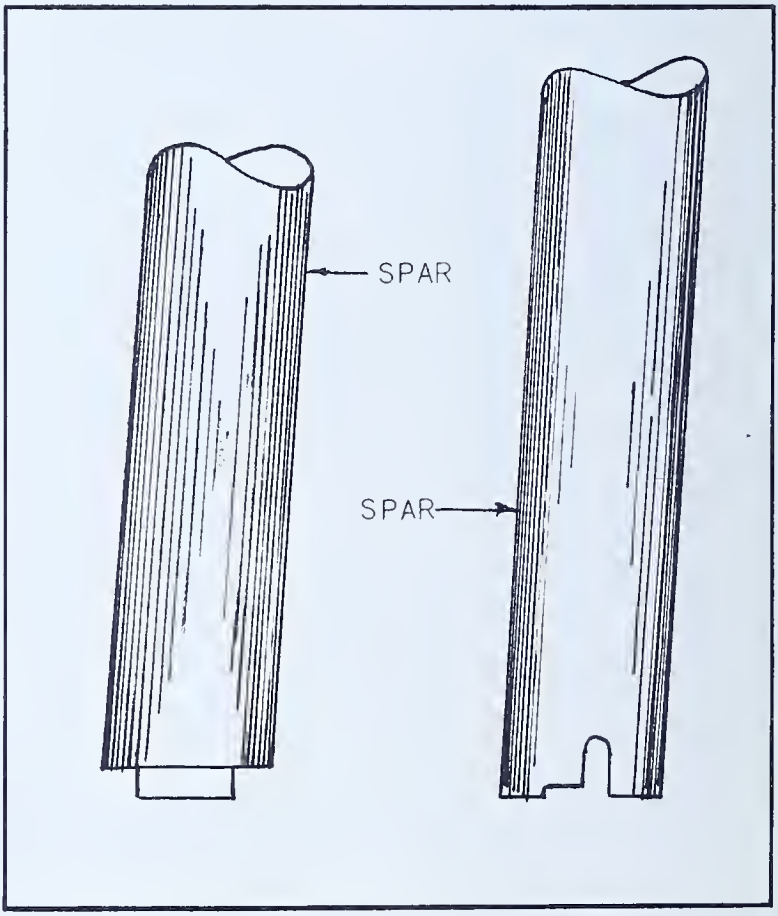


Fig. 211 — *Step Cut to Give Correct "Rake"*

Procedure

1. Consult drawing for rake of mast.
   Mast must have a rake of from ⅛″ to ¼″ to the foot.
2. Caliper mast to get diameter.
3. Take two framing squares and set them on a spar about 3 feet apart and have one of them as near as possible to the spot where the cut will be made. See Fig. 212.
4. Level squares by sighting. See Fig. 212.
5. Measure distance through heel of spar.

*Adapted from "Ship Carpentry," Alabama State Department of Education.

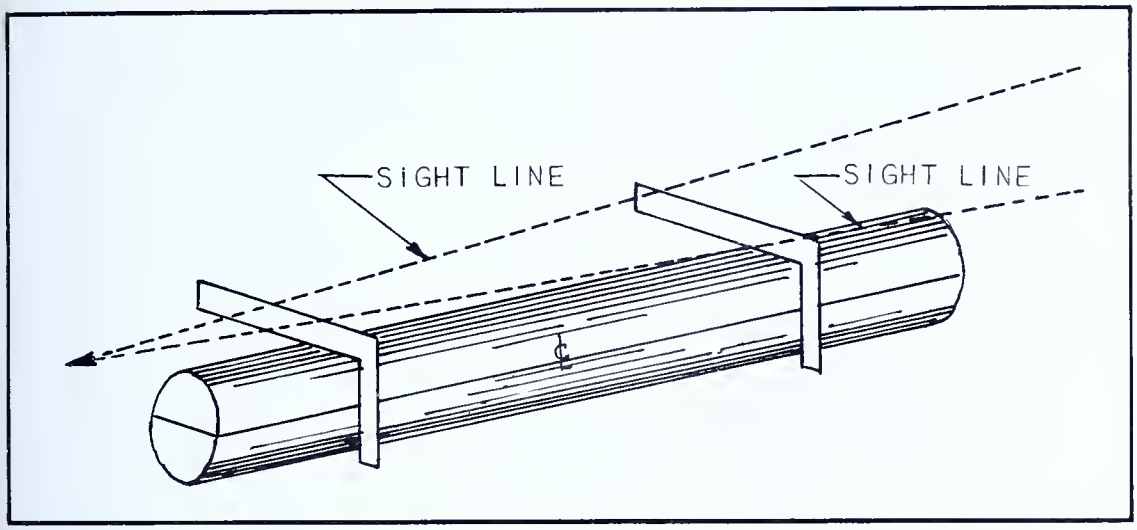


FIG. 212 — *Finding Center Line on Spar*

6. Bisect this distance and locate the distance on squares, beginning at the *inside* of the blades.

7. Strike line on spar across spots on squared timber. See Fig. 209.
   This gives a perfect center line.

8. Nail two battens on spar where cut will be made, and between these battens nail a piece down against spar. See Fig. 213.

9. Hold a square level on center line.

10. Shift battens until proper angle is set. (See blueprint).
    With 18″ leg of square on center line and heel against batten, shift batten until the 12″ leg of square is correct distance from batten. See Fig. 213.

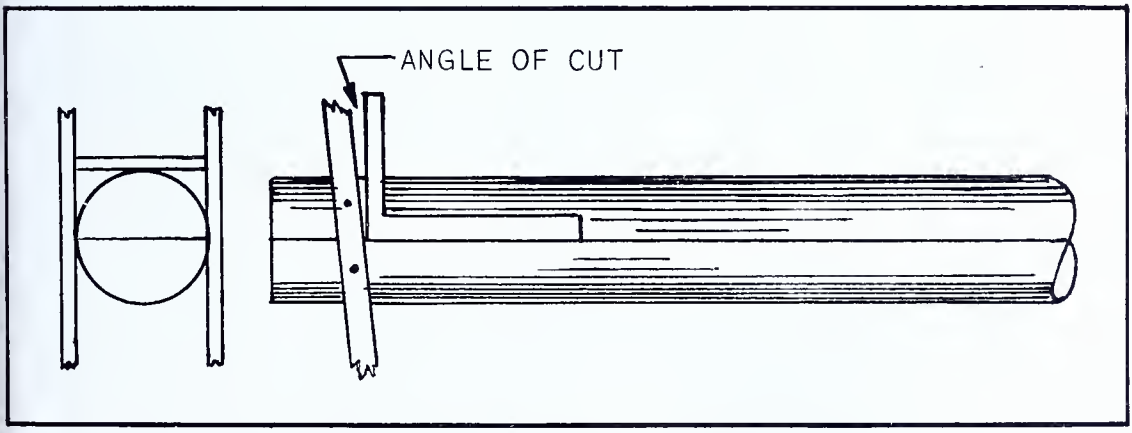


FIG. 213 — *Finding Angle of Cut for Step*

11. Set nails down hard so that batten will not shift. Nail through cross piece.

12. Cut off heel of mast next to batten.

13. Strike center line on butt of spar.

14. Consult drawing, and lay out the size.

15. Cut tenon as shown in Fig. 214.

16. Smooth with plane.

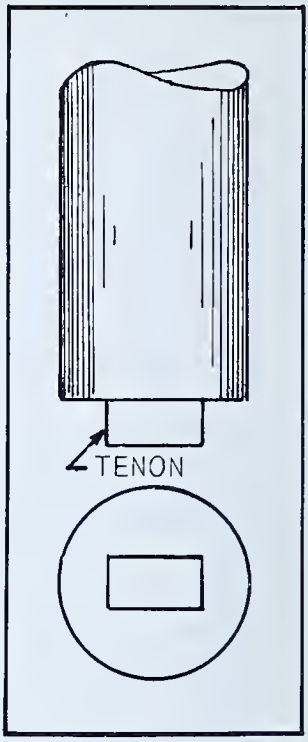


FIG. 214 — *Tenon*

QUESTIONS

1. **Why is it so important to keep center line on this job?**
2. **What is the purpose of the two squares shown in Fig. 212?**

JOB SHEET NO. 16
*FITTING BANDS ON A SPAR

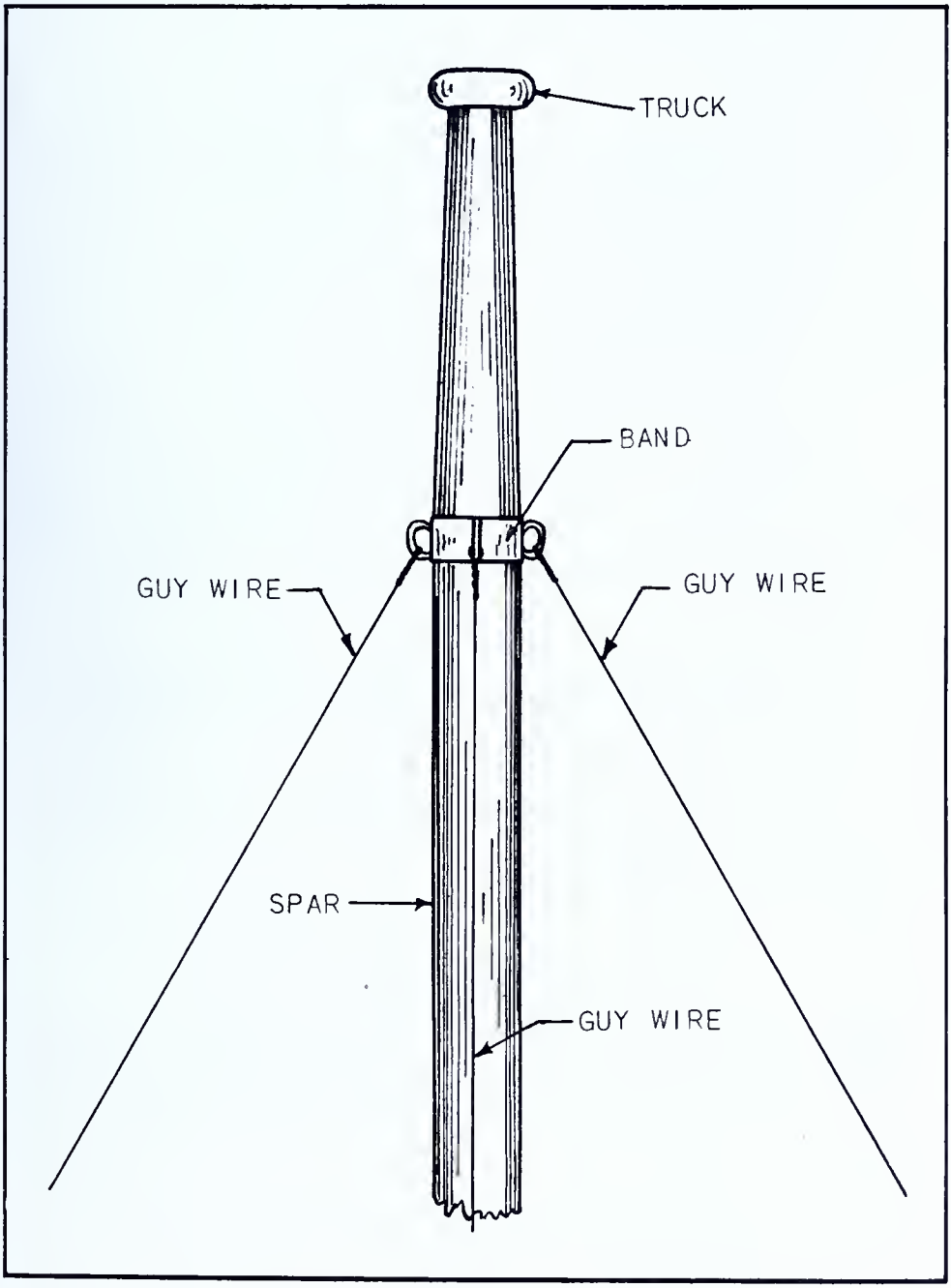


FIG. 215 — *Band Fitted to a Spar*

*Adapted from "Ship Carpentry," Alabama State Department of Education.

General Information

The bands that are used on a spar are made by a blacksmith. They must be galvanized. Bands have lugs on them where the forestay, toppen lifts, shrouds, etc., are fastened. Bands must fit very tight and in some cases they are sweated in place. See Fig. 215.

Tools

1. Draw knife
2. Spoke shave
3. Plane
4. Saw
5. Mallet
6. Chisel
7. Calipers
8. Rule
9. Chalk line

Material

Bands

Procedure

1. Measure inside diameter of band.
2. Caliper spar.
3. Work off wood until spar calipers the same size as inside of band.
4. Strike line from heel to top of spar.
5. Slip band over small end of spar and line up lugs with the center line.
6. Ram or drive the band into place.

QUESTIONS

1. **Why are bands sometimes sweated on?**
2. **Why should a spar be calipered while fitting band?**

JOB SHEET NO. 17
*MAKING A TRUCK AND FITTING IT TO A SPAR

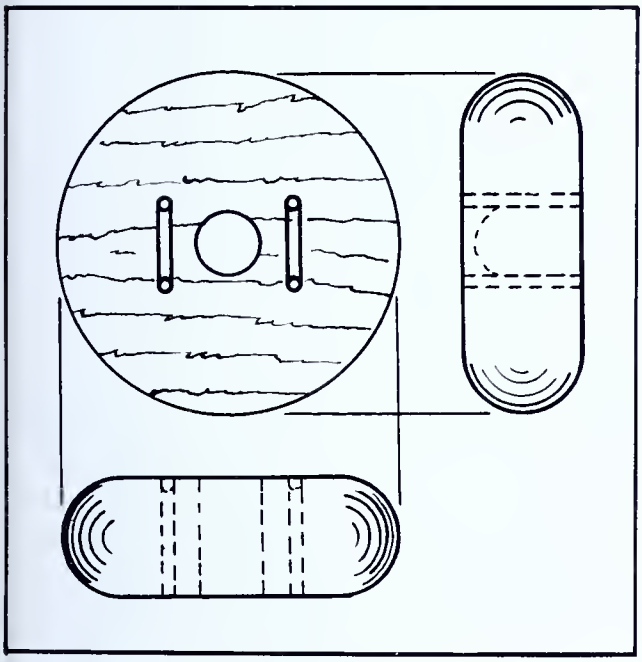


FIG. 216 — *Mast Truck*

Materials

1. 1 pc. lignum vitae or live oak 6″ thick by 14″ square
2. 1½″ lag screw
3. 2 No. 14 x 3″ wood screws

PROCEDURE

1. Set dividers and strike 13″ circle on piece of lignum vitae.
2. Center and fasten material to face plate of wood lathe with screws.
3. Turn material to shape. See Fig. 216.
4. Sand material smooth while it is turning on lathe.
5. Polish material with shavings and linseed oil while it is turning on lathe.
6. Remove material from face plate.
7. Lay off for square or round tenon hole to fit tenon on mast.

GENERAL INFORMATION

A truck is fitted to the top of a mast or flag staff and has a sheave or two holes in it for the signal halyard to run through. The truck is turned on a wood lathe in most cases, but sometimes it is worked out by hand. Very sharp tools must be used on this job and the carpenter must be careful to avoid injuries from sharp cutting edges.

Tools

1. Saw
2. Chisel
3. Mallet
4. Lathe tools
5. Brace
6. Bit

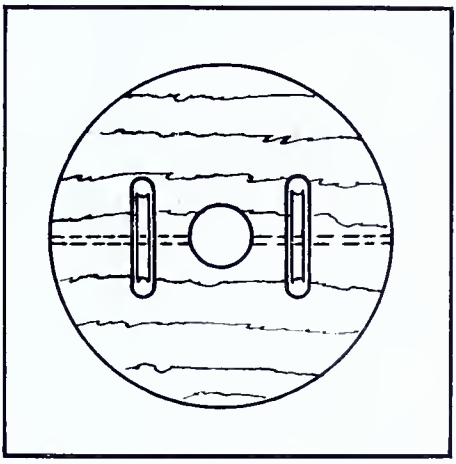


FIG. 217 — *Mast Truck and Sheaves*

*Adapted from "Ship Carpentry," Alabama State Department of Education.

8. Mortise or drill tenon hole in truck. See Fig. 216.
9. Lay off holes for halyard. See Fig. 216.
10. Bore four ½″ or ⅝″ holes and chisel out for sheave. See Fig. 217.
11. Gouge out a semicircle between the holes on top of the truck so that the halyard can slide through easily. See Fig. 216.
12. Find center of top of mast with dividers.
13. Lay off tenon, either round or square.
14. Cut tenon on mast head. See Fig. 218.
15. Fit truck on tenon and drive it in place.
16. Drill hole in center of truck.
17. Fasten with lag screws or wood screws.

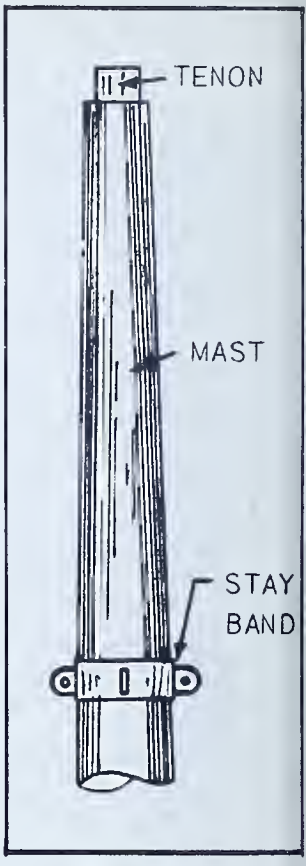


FIG. 218 — *Tenon and Stay Band*

QUESTIONS

1. **What other purpose has the truck than to hold the halyards?**
2. **What advantage has the gouged out hole over the sheave?**

JOB SHEET NO. 18
*MAKING MAST WEDGES

General Information

Mast wedges are used to hold the mast in place where the mast goes through the deck or where a wooden top mast joins the steel lower mast. They are so made that they can easily be removed when the mast has to be unshipped. In some cases a steel mast is held in place with wooden wedges. The same type of wedge can be used in either the lower mast or the top mast. See Fig. 219.

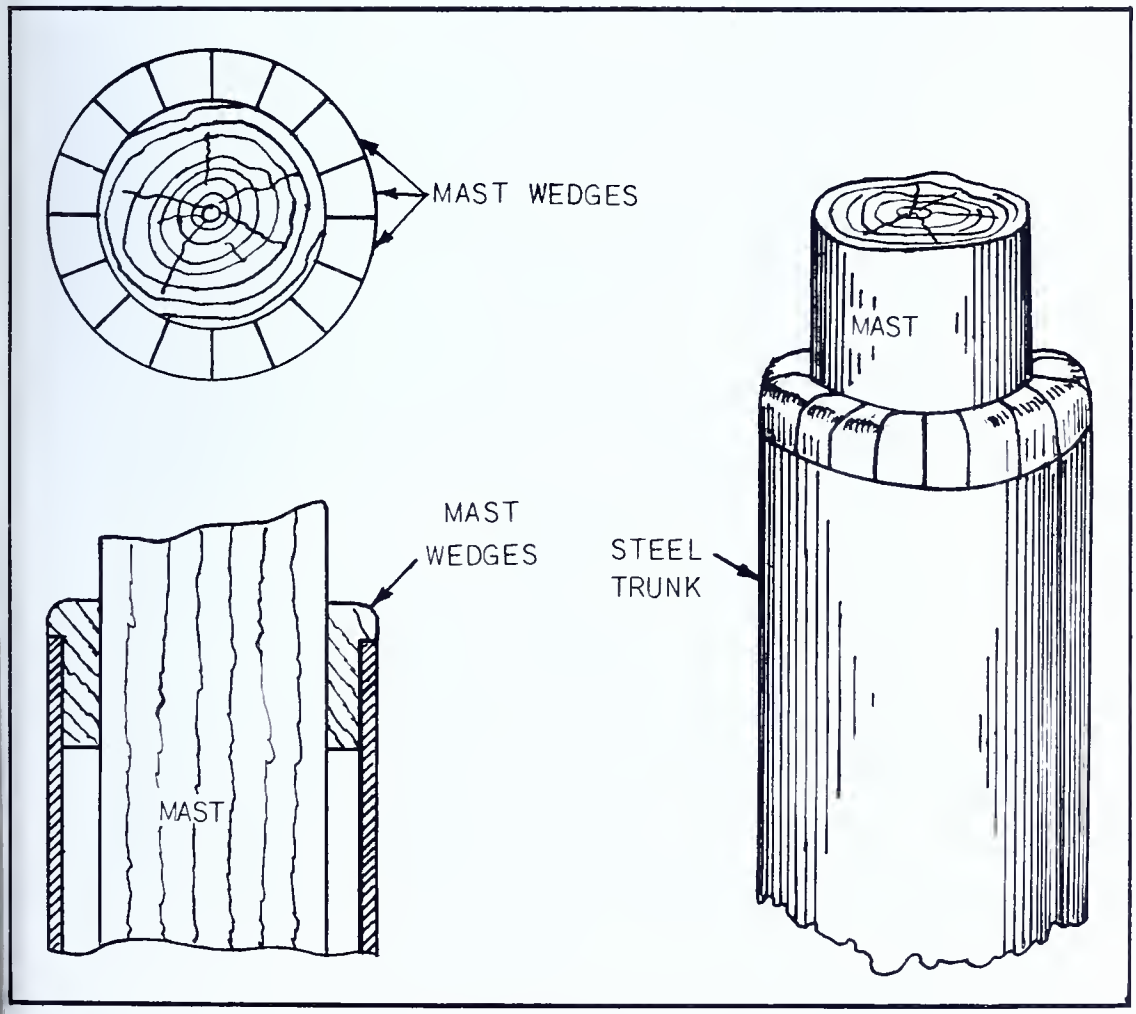


Fig. 219 — *Mast Wedges in Place*

*Adapted from "Ship Carpentry," Alabama State Department of Education.

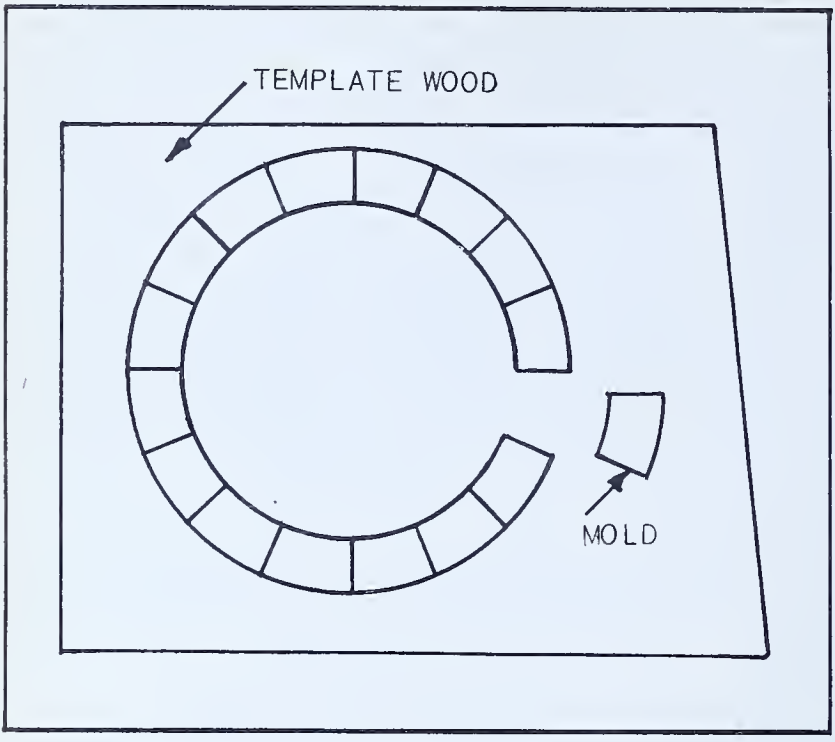


FIG. 220 — *Layout of Mast Wedges*

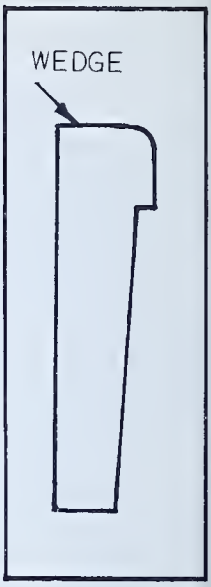


FIG. 221
Template for Wedge

Tools

1. Chisel
2. Mallet
3. Plane
4. Hand saw
5. Bevel
6. Dividers
7. Round sole plane
8. Smooth plane
9. Spoke shave

Materials

1. Oak
2. Pine
3. Fir

PROCEDURE

1. Strike a circle on a piece of template wood 1″ larger than the size of the opening the mast is to go through.
2. Using the same center as in Step 1, strike a circle the size of the mast.
3. Divide this circle into equal parts or the size of the mast wedges. See Figure 220.
4. Saw out mold. See Figure 220.
5. Determine length of wedges. See the leader.
6. Lay off ends of wedges to shape of mold.

7. Saw to the shape of the end.
8. Work out concave sides of wedges.
9. Make template to shape of the side of the wedge. See Fig. 221.
10. Cut wedges to shape of the template.
11. Smooth up wedges.
12. Use four plain wedges and equalize, or center, mast in mast partner. See Fig. 222.
13. Drop all wedges in place. See Figure 219.
14. Drive all wedges equally. Drive a little at a time.
15. Remove temporary wedges.
16. Drop in mast wedges where temporary wedges were removed.
17. Drive all wedges down hard.
18. Clean wedges smoothly with spoke shave, rounding outside edge.
19. Paint over wedges.

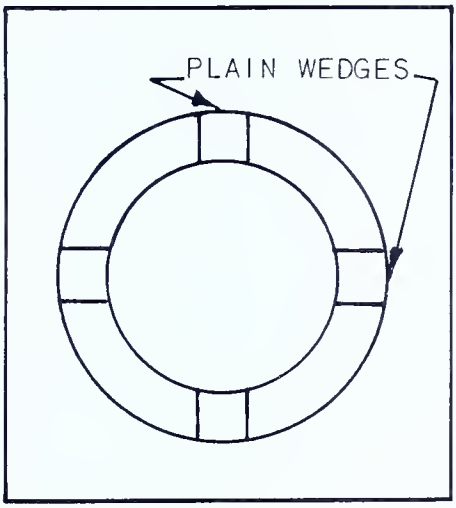


FIG. 222 — *Temporary Wedges to Hold Mast in Central Position*

QUESTIONS

1. **Describe the method of preparing the template for marking out the wedge mold.**
2. **Why is a template necessary for the wedge shape shown in Fig. 221?**
3. **Why are wedges not put in and driven down one at a time?**
4. **Why are steel wedges not used?**
5. **Of what use are the temporary wedges shown in Fig. 222?**

JOB SHEET NO. 19
*LAYING OUT, HEWING, AND ROUNDING UP BOOM

General Information

All cargo ships use booms as a means to load and unload cargo. Some cargo ships use steel booms, but most shipbuilders prefer a good wooden boom because a wooden boom lasts longer. See Fig. 223. Material for a large cargo boom is very hard to find today as it must be at least 50 ft. long and free from harmful knots and sapwood. The work of laying out and shaping a boom calls for a skilled carpenter.

Special Safety Precaution

Be careful to avoid injuries from edged tools.

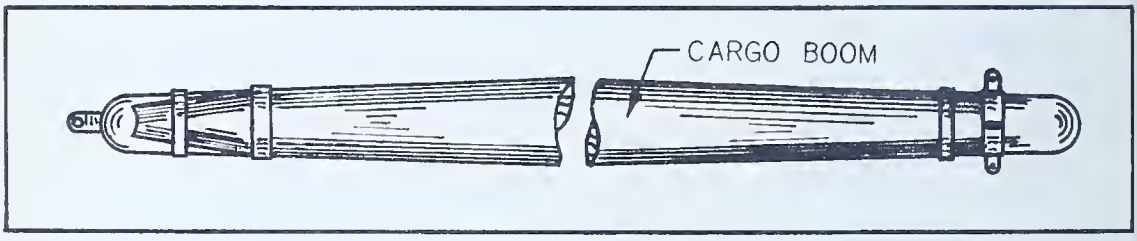


Fig. 223 — *Finished Wooden Boom*

Tools

1. Square
2. Saw
3. Chisel
4. Mallet
5. Axe
6. Adz
7. Spoke shave
8. Spar plane
9. Jack plane
10. Smooth plane
11. Draw knife
12. Chalk line

Materials

Stick of timber (usually yellow pine or fir), chalk.

Procedure

1. Place stick on rollers back of, and in line with, the ship's saw.
2. Strike a center line the full length of stick.
3. Consult drawing for length and swell of boom.
4. Mark locations of bands and gooseneck of boom. See drawing for these locations.
5. Spot in between bands equally.

*Adapted from "Ship Carpentry," Alabama State Department of Education.

6. Consult drawing for sizes at spots.
7. Lay off sizes of boom at spots, working from center line. See Fig. 224.
8. Strike a line on these spots.
   This will give the shape of the boom. See Fig. 224.

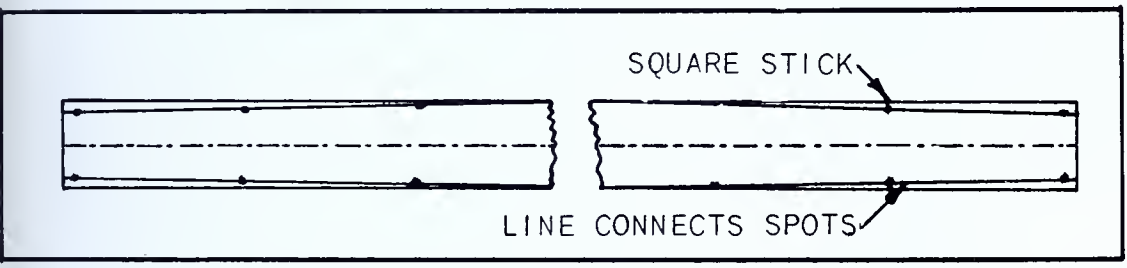


FIG. 224 — *Laying Out Boom Spots for Size*

9. Saw on ship's saw to lines.
10. Turn boom one quarter turn.
11. Repeat layout.
12. Saw on ship's saw to lines.
13. Refer to "eight-square" scale. See Fig. 206.
14. Lay off "eight-squares." See Fig. 225.

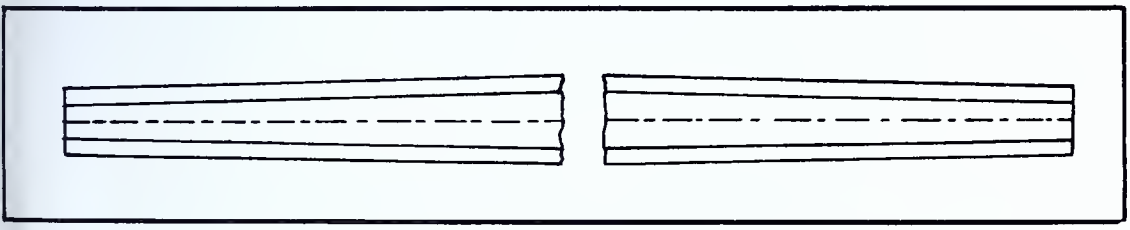


FIG. 225 — *Boom Laid Off for "Eight-Squares"*

15. Repeat layout on all four sides.
16. Saw to "eight-square" lines.
    It is common practice to saw a boom, but a mast must be hewed out by hand.
17. Divide distance between "eight-square" lines and lay out "sixteen-square" lines.
18. Hew to "sixteen-square" lines.
19. Round up boom with a draw knife.
20. Straighten up with a spar plane or a fore plane.
21. Smooth up with a smooth plane.

QUESTIONS

1. Why is a boom made with a swell in it?
2. Why is it necessary to work from a center line?
3. Why is a stick "eight-squared" and "sixteen-squared"?

JOB SHEET NO. 20
*FITTING GOOSENECK AND BANDS

General Information

The gooseneck band is a means of fastening the boom to the mast. The topping lift band is a means of supporting the boom at any angle. See Fig. 226. The fitting of these bands calls for a high degree of skill as they have to be held to a close fit. Be careful to avoid injuries from sharp edged tools on this job.

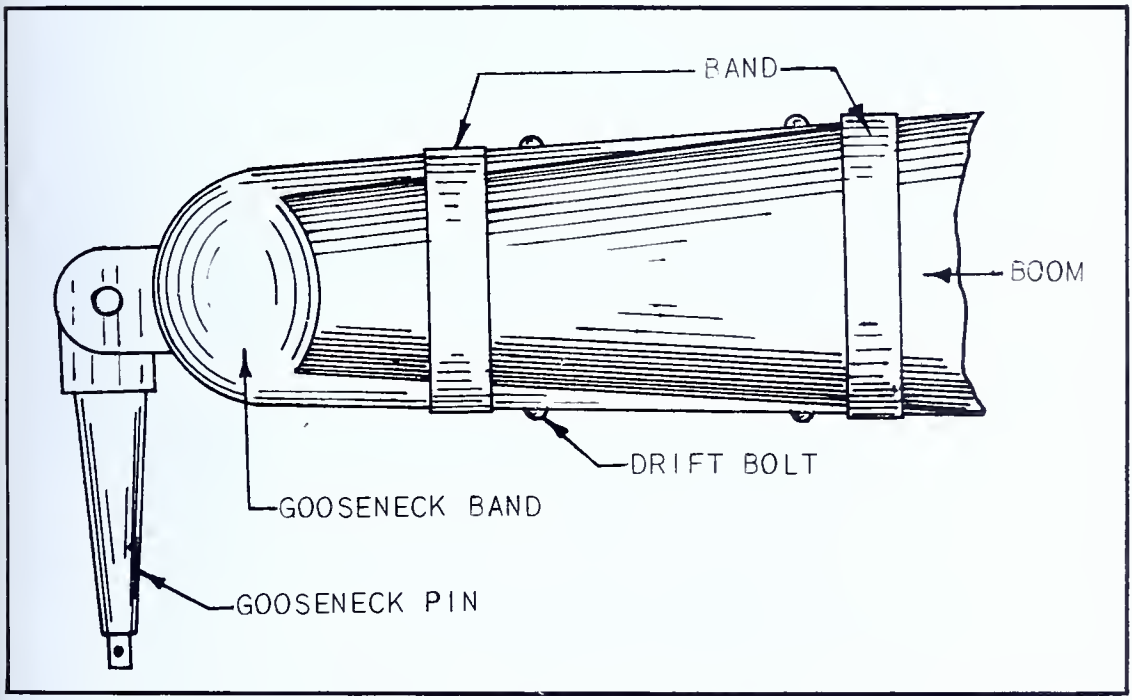


Fig. 226 — *Goose Neck Installed*

Tools

1. Chisel
2. Mallet
3. Square
4. Spoke shave
5. Slice chisel
6. Rabbet plane
7. Brace and 11/16″ bit
8. Ball peen hammer

Materials

¼″ drift bolts with countersunk heads and pilot point, goose neck band, toppen lift band.

*Adapted from "Ship Carpentry," Alabama State Department of Education.

PROCEDURE No. 1
FIT GOOSENECK BAND

1. Find exact center on each end of boom with dividers.
2. Mark center spot.
3. Set a straightedge on spots on each end of boom. See Fig. 227.

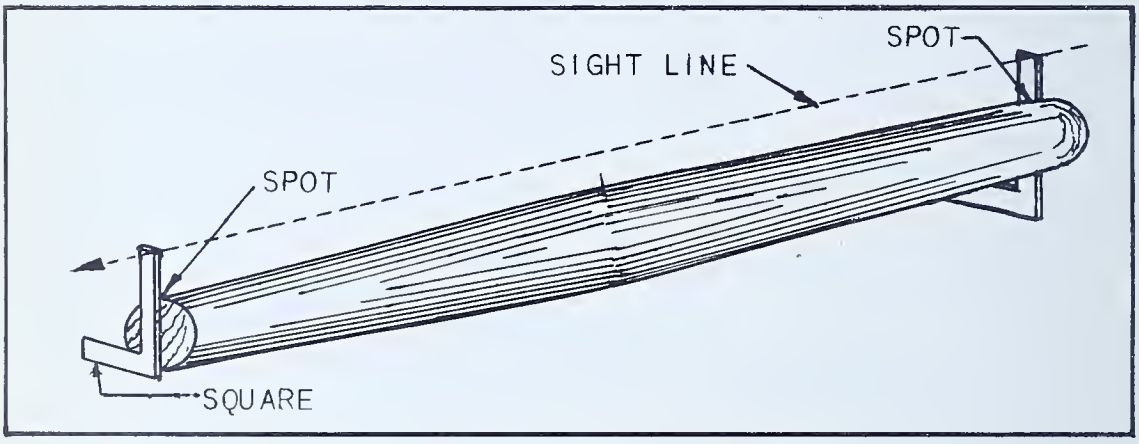


FIG. 227 — *Sighting a Center Line With Squares*

4. Sight and move straightedges until both are in line.
5. Mark spots on both sides and ends of boom where straightedge touches.
6. Strike a line the full length of boom, on both sides and ends at spots.
7. Measure width of gooseneck band.
8. Lay off width from center line on boom.
9. Make a mold or template to the shape of the gooseneck band.
10. Cut out shape of gooseneck band in boom.
11. Try mold in cut and fit until mold is flush with boom.
12. Try gooseneck band for fit.
13. Fit gooseneck band.
14. Drive bands on to hold gooseneck band in place. See Fig. 228.
15. Bore holes for bolts.
    Bore half way through boom from each side.
16. Drive bolts through.

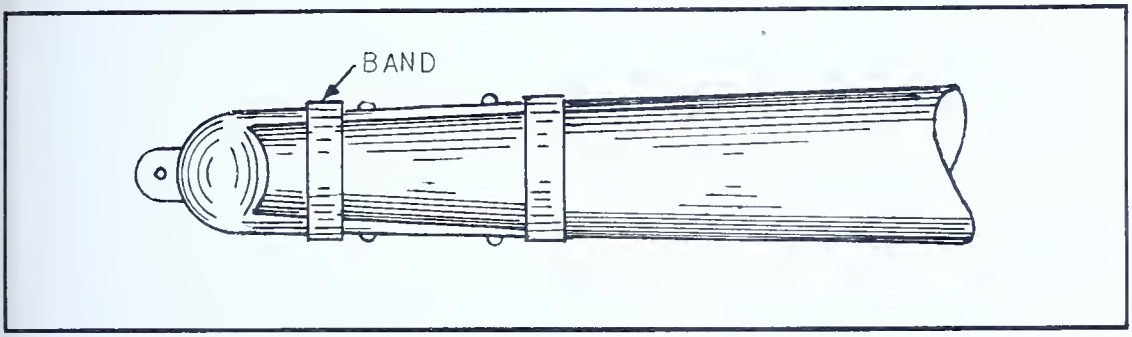


FIG. 228 — *Gooseneck Band in Place*

17. Cut excess part of bolt off with hack saw.
18. With a ball peen hammer rivet head on sawed-off end of bolt.
19. Smooth up end of boom with spokeshave.

PROCEDURE NO. 2
FIT TOPPING LIFT BAND, BONNET TYPE

1. Caliper inside of bonnet band.
2. Caliper end of boom to the diameter of bonnet band and cut shoulder. See Fig. 229.
3. Measure width of bonnet band.
4. Taper shoulder to receive bonnet band. See Fig. 229.
5. Drive bonnet band in place.

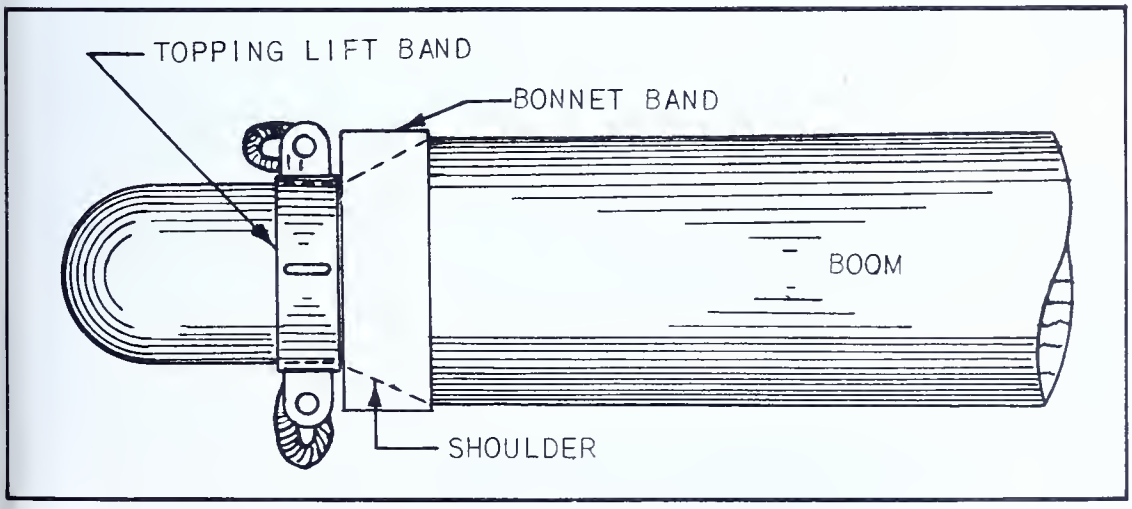


FIG. 229 — *Bonnet Band in Place*

6. Slip topping lift band over end of boom.
7. Drive up hard against bonnet band.
8. Tighten topping lift band.

PROCEDURE No. 3
FIT STRAP BAND

1. Cut shoulder as in procedure No. 2 and fit topping lift band.
2. Remove topping lift band.
3. Find center of end boom.
   Use dividers.
4. Strike center line on top and bottom side of boom.
5. Measure width of strap band.
6. Lay out width of strap band working each side of center line on boom.
7. Chisel out or work out with rabbet plane until strap fits flush in boom.
8. Slip strap band in place.
9. Slip topping lift band over strap band.
10. Tighten up topping lift band.
11. Smooth up end of boom with spoke shave.

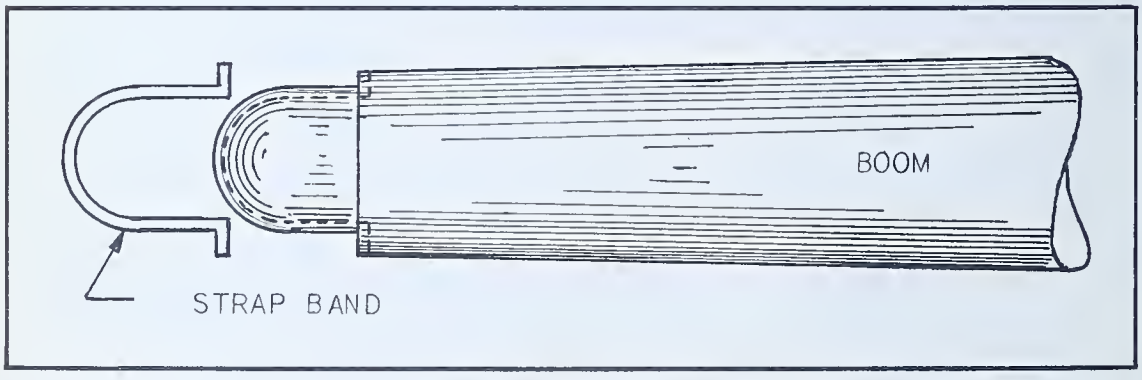


FIG. 230 — *Boom Ready to Receive Strap Band*

QUESTIONS

1. **Why is a bonnet band used?**
2. **Why is a strap band used?**
3. **Why are small bands used over the gooseneck bands?**

JOB SHEET NO. 21
SETTING BOOM CHOCKS

General Information

Booms are long, tapered, wooden timbers used to load and unload cargo. The end of the boom rests in the chock while the ship is at sea or while the boom is not in use. The chock is bolted to the stand with eye bolts, and these in turn support the clamp or band which holds the boom in position. See Fig. 231.

Tools and Materials

1. Dividers
2. Brace
3. Bit
4. Hammer
5. Chisel
6. Spoke shave
7. Chalk line
8. Rasp or gouge
9. Eye bolts

Other Mechanic Needed:

Driller.

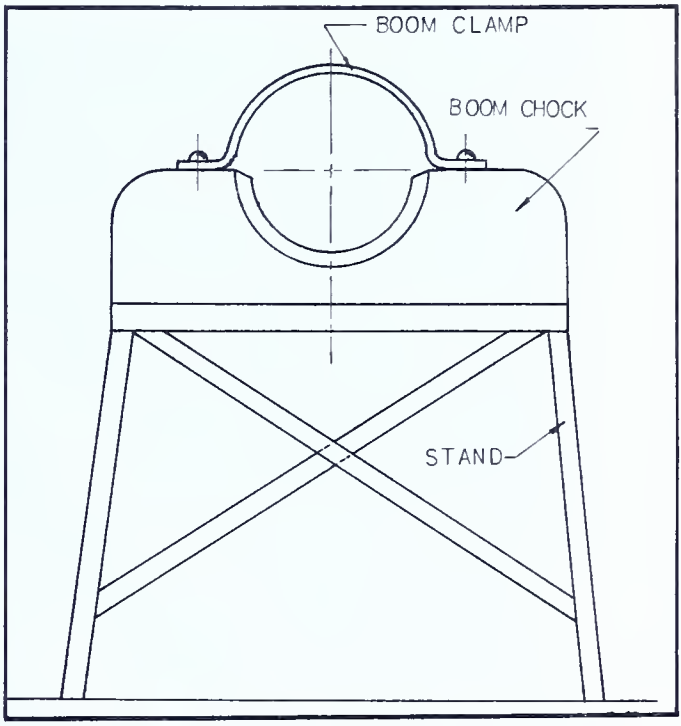


Fig. 231 — *Boom Chock and Supporting Stand*

Procedure

1. Secure a piece of stock to fit the top of the stand. The size is approximately 8″ x 10″ x 2′-0″.

2. Determine the bevel to which the chock must be cut.

   Stretch a line from the king post connection to the center of the chock. Adjust the bevel to this cut.

3. Caliper the boom at the point where it will rest in the chock.

Fig. 232 — *Twin Booms in Chock*

4. Set dividers to the radius of the boom measurement.
5. Swing the radius with the dividers.
6. Mark the bevel lines.
7. Saw out the half circle on the band saw.
8. Fit the chock until the boom lies neatly in the chock.
   Smooth down with spokeshave, gauge, and sandpaper.
9. Cover the inside surface of the chock with sheet lead. Cut and tack into place with galvanized tacks.

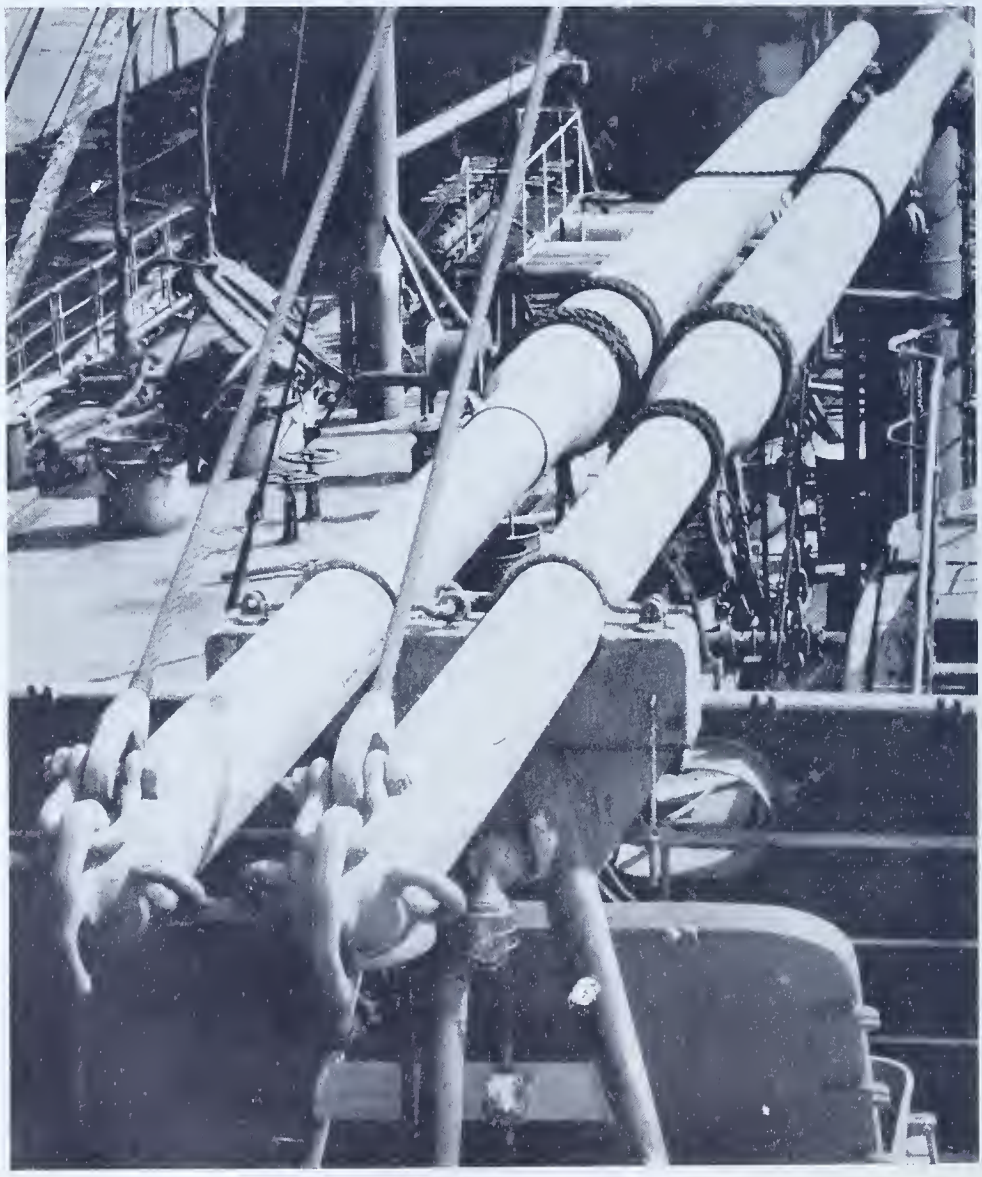


FIG. 233 — *Twin Booms Secured in Place*

10. Round off the corners of the chock.

11. Bolt the chock to the stand.

    Bolts run entirely through the chock into the top piece on the stand.

12. Place boom clamp.

    The boom clamp fits over the boom to hold it securely in position. It is fitted with a keeper so that it can easily be detached.

13. Paint the chock.

QUESTIONS

1. **What is the purpose of the boom rest?**
2. **Why must the boom chock be placed on a stand?**
3. **What is the purpose of lining the chock with lead?**
4. **How is a boom chock fastened to the stand?**
5. **How is the bevel determined when cutting the chock?**
6. **At what point is the boom measured to obtain the chock cut-out size?**
7. **Explain how the boom is locked in the chock.**

JOB SHEET NO. 22
MAKING A JACK STAFF AND FLAG STAFF

General Information

The jack staff is mounted on the bow of the boat and the jack is hoisted on it. The flag staff is mounted on the stern and the flag is flown from it. The flag staff is longer than the jack staff. The flag staff is held in place by a clamp on the ship's rail, and by a pin that goes through the base of the staff on the deck. See Fig. 234.

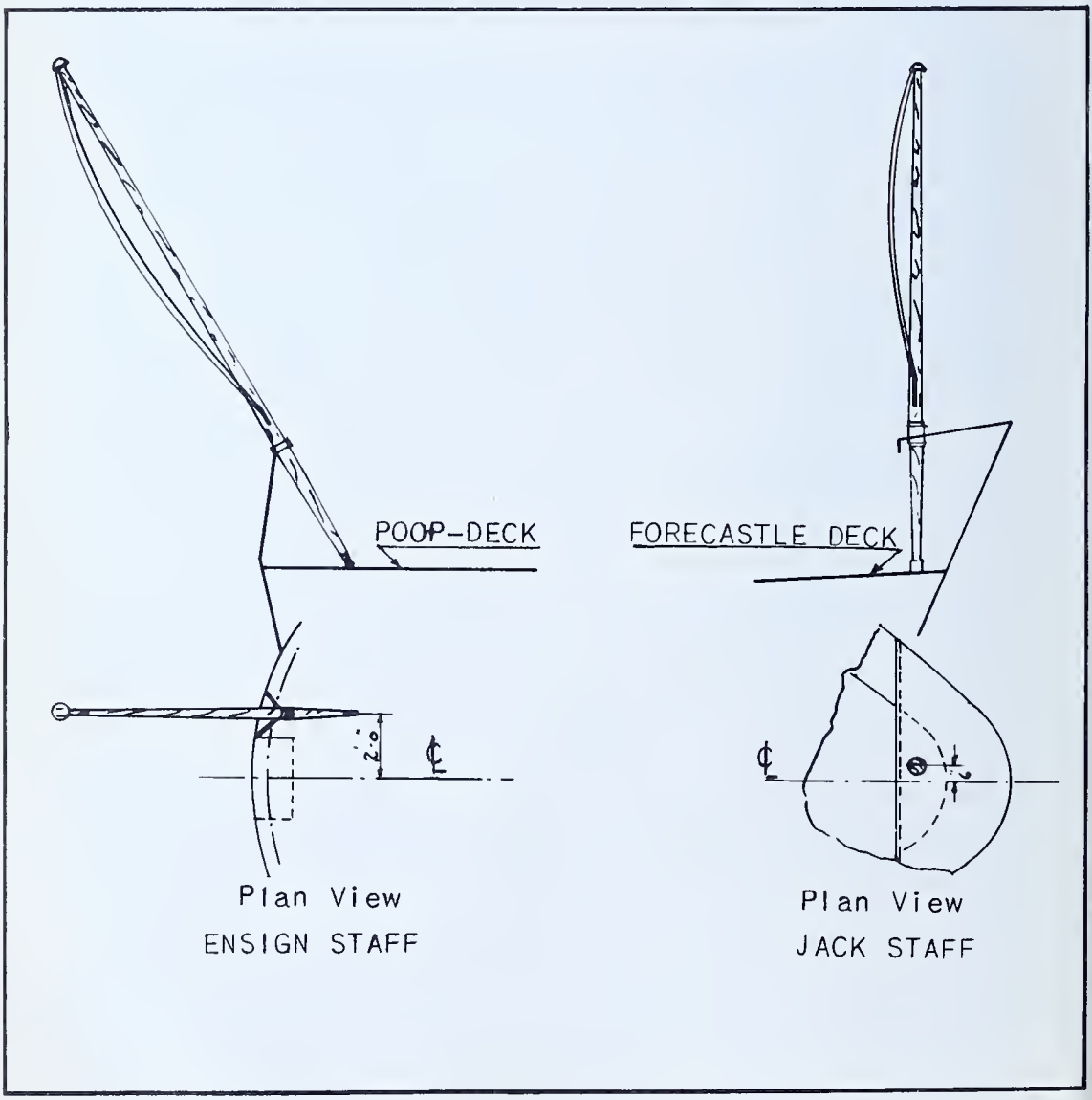


Fig. 234 — *Plan and Elevation of Flag Staffs*

Tools

1. Hand saw
2. Draw knife
3. Chisel
4. Mallet
5. Plane
6. Brace
7. Bit

Materials

1. Fir
2. Cypress
3. Yellow pine, 4½ to 5″ thick, 14′ long.

PROCEDURE

1. Strike a center line the entire length of the material.
2. Consult drawing for size of staff.
3. Spot sizes on material.
4. Connect spots with chalk line.
5. Saw to these lines.
6. Give the material a quarter turn.
7. Repeat layout.
8. Saw to line.
9. Smooth with fore plane.
10. Lay out "eight-square". See Fig. 203.
11. Saw to "eight-square" line.
12. Round material with draw knife.
13. Smooth with fore plane.
14. Smooth with smoothing plane.
15. Cut steps.
16. Fit step to socket. (Socket is welded to deck).
17. Fit truck to top of staff.
18. Sand smooth.
19. Varnish.

QUESTIONS

1. On a small staff or spar, why is it unnecessary to use "sixteen-squares"?
2. Why is the flag staff removable?
3. How is the ensign staff secured?
4. On which end of the ship is the jack staff placed?
5. Compare the layout of a jack or ensign staff with the layout of a boom.

JOB SHEET NO. 23
CHOCKING LIFEBOATS

General Information

Boat davits are radial arms from which the lifeboats are suspended. The davit arms swing outboard so that the lifeboat can be lowered into the water by the blocks and falls. The shipfitter usually installs the lifeboat davits and the skid on which the chocks rest.

The chocks fit the curvature of the boat. As a rule the chocks are on the inboard side only, but on different type boats and by request of different inspectors, the chocks are sometimes placed on both sides of the boat. See Fig. 235. Lashing the boat to these chocks prevents the boat from tipping overboard. See Fig. 236.

Study the blueprint carefully before attempting to do the job. Determine the type of chock to be used, the method of fastening, the type of gear necessary for the release of the boat, etc.

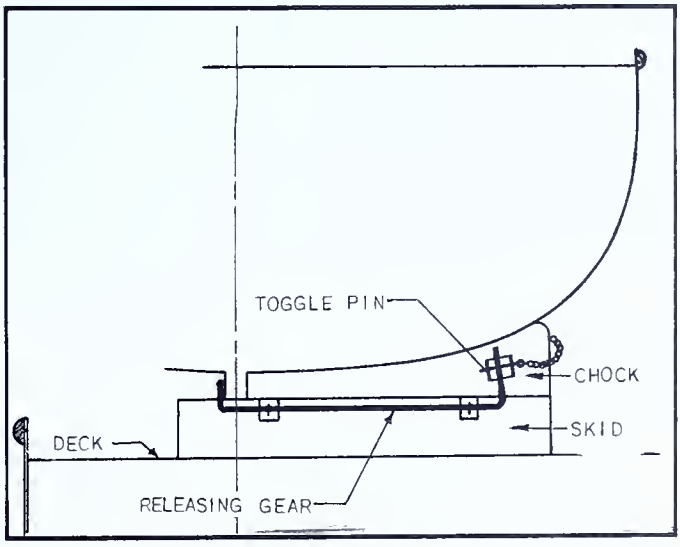


Fig. 235 — *Lifeboat Chock*

Special Safety Precautions

The carpenter works close to the edge of the deck on this job. Avoid throwing materials about the deck which may cause workers to stumble. A careless step can cause a bad fall.

Tools and Materials

1. 6′ rule
2. Knife
3. Adz
4. Spokeshave
5. Brace and bit
6. Wrench
7. Hammer
8. Chisel

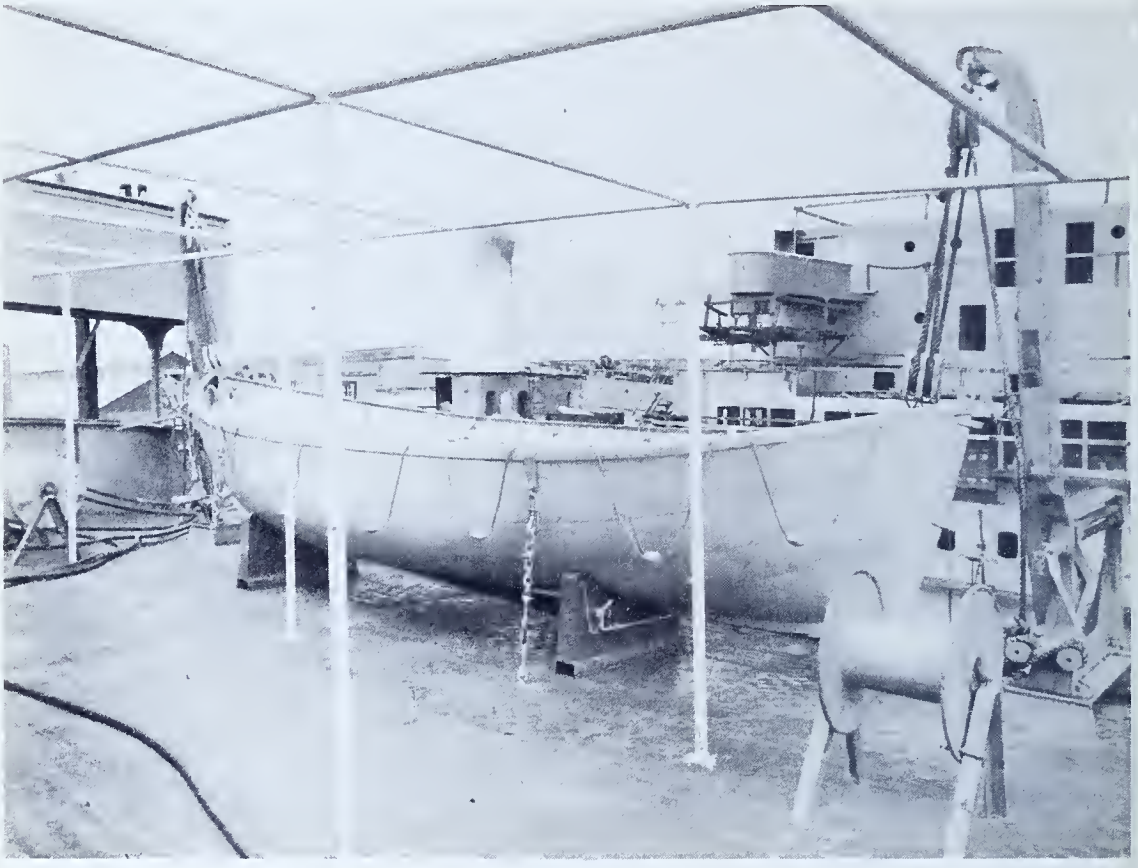


FIG. 236 — *Lifeboat Resting on Chocks and Secured With Gripes*

PROCEDURE

1. Have the riggers hang the lifeboat. The lifeboat is hooked to a block and fall which is suspended from the davits.
2. Lower the boat until the keel rests on the skids.
3. Plumb and align the boat. If the ship has not been launched, this operation is performed with a level; if the ship has been launched it is usually aligned with some object on the deck.
4. Shore the boat in a level position.

   One shore on each side of the boat is usually sufficient.
5. Make a chock template to fit the curvature of the boat. See Fig. 237.

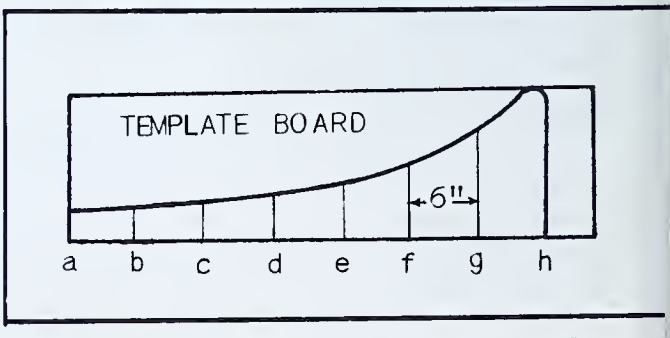


FIG. 237 — *Laying Out Chock Template*

A. Mark 6″ intervals on the skid, as shown in Fig. 237.

B. Draw lines on the template board at 6″ intervals.

C. Measure vertical heights from the skid to the boat bottom. See Fig. 238.

D. Transfer these measurements to the corresponding lines on the template board.

E. Draw a line through the established points.

F. Cut out the template with a knife.

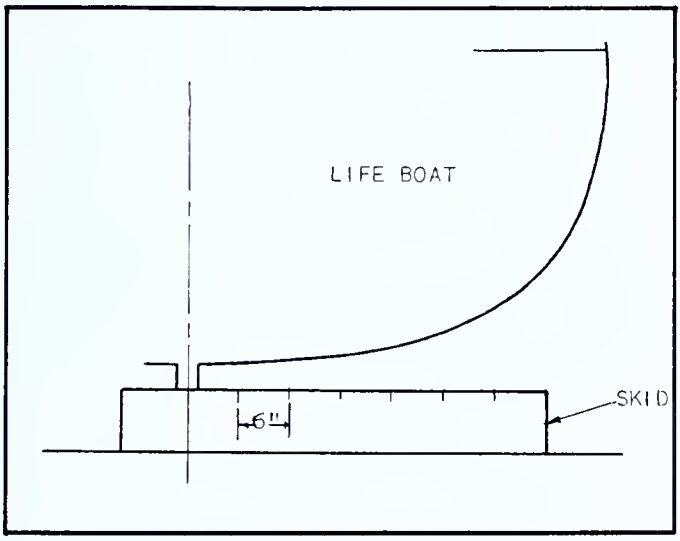


FIG. 238 — *Laying Out Skid for Measurements*

6. Test the template for fit.
   If the template does not fit perfectly, scribe the template and re-cut.

7. Lay out template on a 4½″ thick surfaced plank.

8. Cut the chock to shape.
   The material is taken to the shop and cut out on the bandsaw.

9. Smooth the curvature with a spokeshave.
   The chock must be worked out with the spokeshave until it fits the curvature of the boat perfectly. The edges are rounded.

10. Fit the chock in exact position.

11. Hoist the boat and turn the davits overboard to clear the working space.

12. Bolt the chock to the skid.
    The skid is bolted from the under side into the bottom of the chock.

13. Place the releasing gear. See Fig. 235.
    The releasing gear prevents the boat from sliding off the chocks. The gear is released by drawing the toggle pin and pushing down the gear handle. The gear assembly is placed into position and bolted directly to the chock.

14. Make up and place the gripe. See Fig. 239.

The gripe arrangement holds the boat securely on the chocks. It is made of chain fitted at one end with a turnbuckle and an eye pad for attachment to an eye bolt welded or bolted to the deck. On the other end is a shackle, a pelican, and a flat bar hook for attachment to the gunwale of the boat.

QUESTIONS

1. **Where are lifeboats located?**
2. **Describe the procedure for laying out a chock template.**
3. **What is a pelican and why is it used?**
4. **List the parts of a gripe assembly.**
5. **To what and how are chocks fastened?**
6. **Why are chocks placed on only one side of the boat?**
7. **What is the purpose of the releasing gear?**

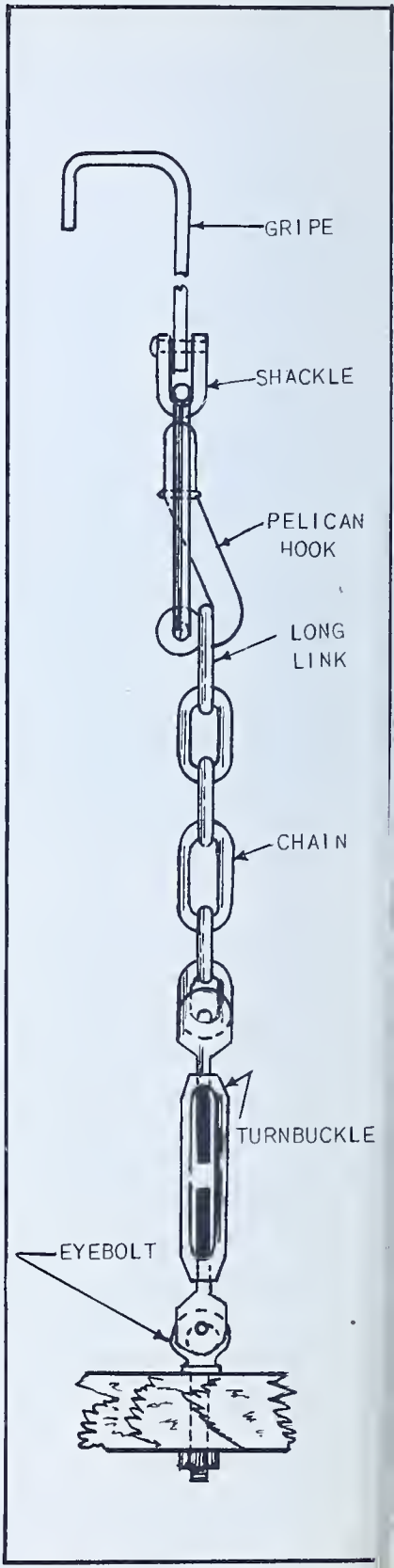


FIG. 239 — *Gripe Assembly*

JOB SHEET NO. 24
*BUILDING WOODEN COVERS FOR A LIFEBOAT

General Information

Covers are used on lifeboats to keep water out of them and to protect them from the sun. Some boats are equipped with canvas covers while others have wooden covers. The wooden cover will outlast the canvas one and is more easily kept in place. Wooden covers are built in sections to facilitate their removal when necessary. See Fig. 240.

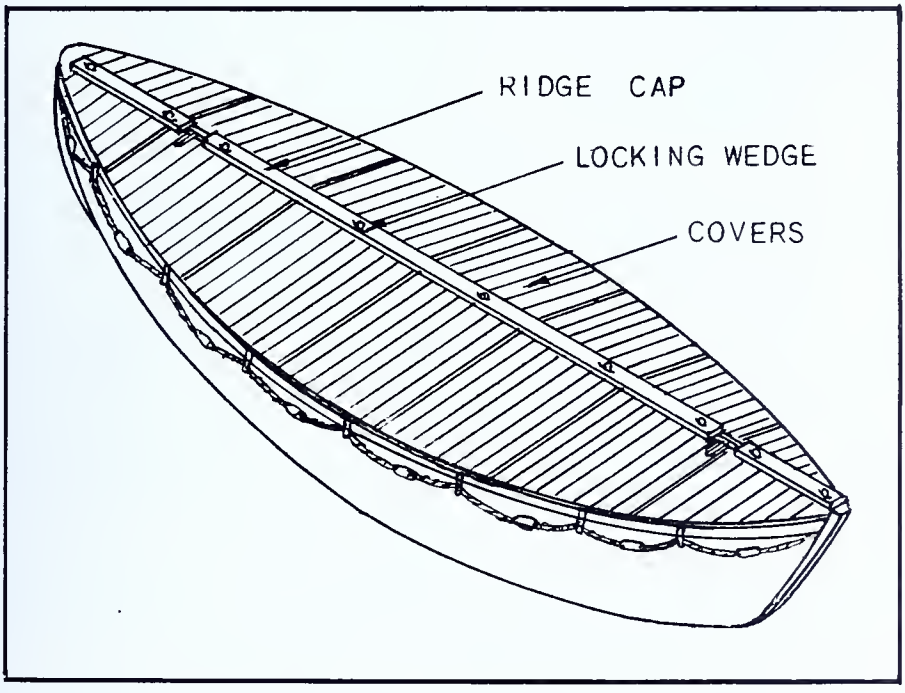


Fig. 240 — *Wood Cover Installed on Lifeboat*

Tools	Materials
1. Hammer	Pine, fir, cypress, ridge piece 3″ x 6″ by length of boat
2. Saw	Spreaders 3″ x 3″ x 6′
3. Rule	Saddles 3″ x 3″ x 6′
4. Chisel	Lock ridge 2″ x 4″ by length of ridge
5. Brace and bits	Cypress ceiling 1″ x 4″ x 6′
6. Screwdriver	Oak wedges
7. Bevel square	6-penny common galvanized nails
8. Mallet	No. 12 x 2″ F. H. brass screws
9. Jack plane	8″ staples made from ⅜″ iron rod and galvanized
10. Smooth plane	
11. Straight edge	

*Adapted from "Ship Carpentry," Alabama State Department of Education.

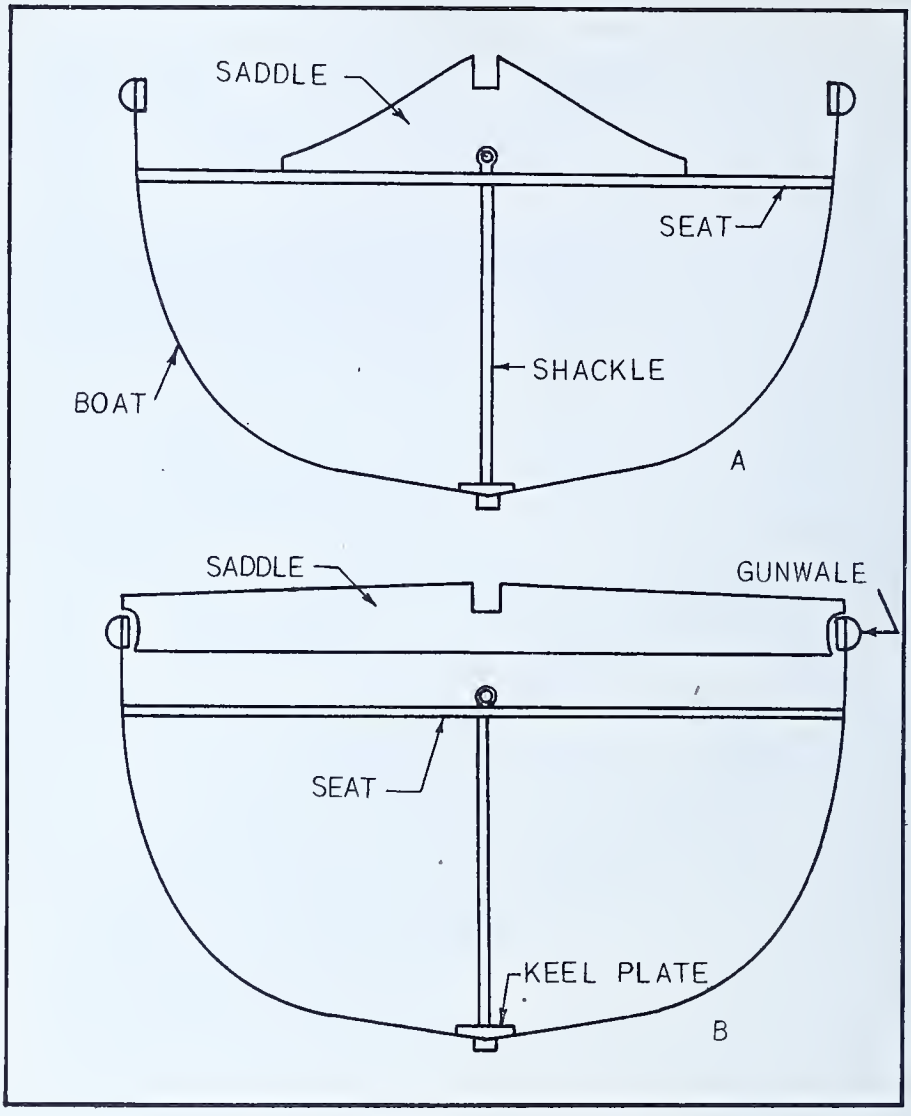


FIG. 241 — *Lifeboat Cover Saddles*

PROCEDURE

1. Determine position for saddles.

   The saddles support the main ridge of the boat covers. In some instances the saddles rest on the front and rear thwarts, or seats, of the lifeboat. See Fig. 241 at "A". In other cases they are cut to fit so that they will rest on the gunwales of the boat. See Fig. 241 at "B".

2. Make a template of the right shape to cut the saddles.

3. Try the template for the correct fit at each end of the boat.

   The notch for the ridge is laid out on the saddle at the correct depth to bring the top edge of the ridge even with the top of the stem and the stern of the lifeboat when the saddles are in place.

4. Lay out four saddles and cut to shape. See Fig. 241.

5. Fit the saddles to the gunwale.

   A saddle must be placed each side of the lifting shackle in the lifeboat to leave enough room for the boat falls to fasten in place. See Fig. 242.

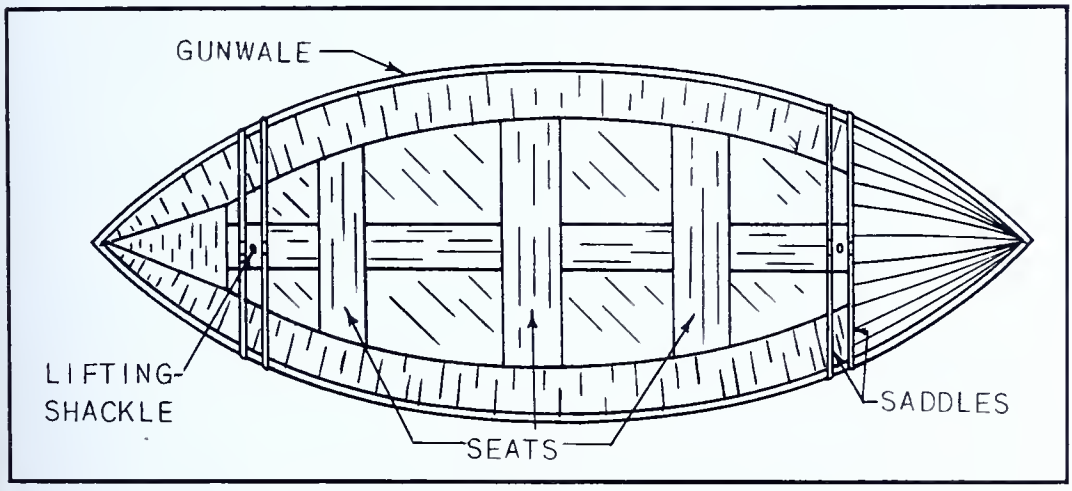


FIG. 242 — *Lifeboat and Saddles*

6. Measure the length of the lifeboat.

7. Cut the ridge to this length out of 3″ x 6″ stock. See Fig. 243.

8. Stretch a line from the top center of the stem to the top center of the stern of the lifeboat.

9. Drop a line from the line previously stretched the length of the boat so that the plumb line will strike the center of the lifeboat keelson.

10. Place a small straightedge to touch the line previously stretched the length of the boat; one end of the straightedge touching the line and the other end of the straightedge touching the gunwale of the lifeboat.

    The angle or bevel formed by the straightedge and the plumb line is the bevel of the rabbet on the ridge. Use a T-bevel to take this angle.

11. Cut a rabbet on each side of the ridge $\frac{7}{8}$″ deep and to the correct angle. Leave about $1\frac{1}{2}$″ of wood across the top of the ridge. See Fig. 244.

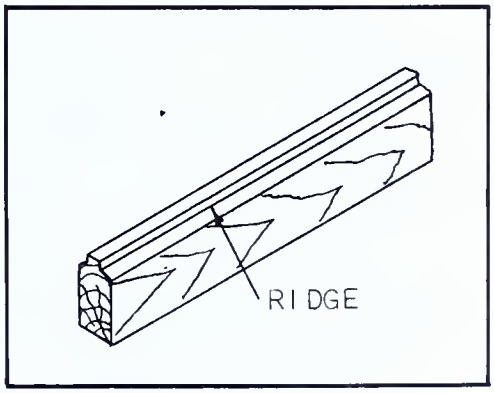


FIG. 243 — *Ridge Timber*

12. Set the ridge in the saddles and plumb them.

13. Mark the position of each saddle notch on the ridge.

14. Remove the ridge and cut a notch across the bottom line of the ridge at the saddle marks.

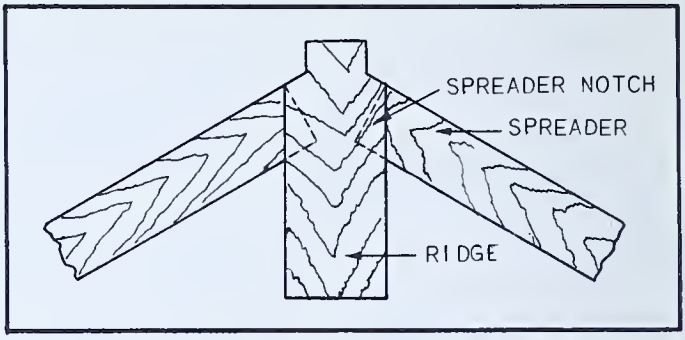


FIG. 244 — *Ridge and Spreaders*

These notches will keep the saddles from sliding on the ridges.

15. Select spreader material and cut a groove about ½″ deep and ½″ wide in the top side of spreader material.

16. Find the center of the ridge between ends and lay off a distance ot 2″ to 2½′ each way from the ridge center just found.

The two centers laid off last are the centers of the notches (Fig. 244), into which the ends of the spreaders fit.

17. Cut one end of each spreader square. See Fig. 244.

18. Cut notches in the ridge to receive the spreaders. The centers of these notches were laid off in step 16.

19. Obtain a piece of template wood the same width as the spreaders, and shape template wood to fit over the gunwales of the boat, leaving about 1″ of wood above the gunwales.

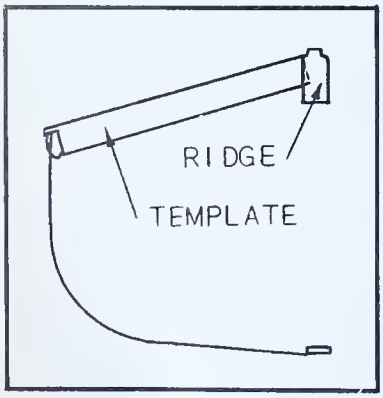


FIG. 245 — *Spreader Template*

Each spreader will require a template, as the shape of the boat will not be the same at each spreader. See Fig. 245.

20. Cut spreaders to shape of templates.

21. Cut a notch next to the ridge on the spreader and a notch next to the gunwale on the spreader, on both sides, for cover battens to fit into. See Fig. 246.

22. Cut and fit battens to grooves in spreaders.

In fitting battens to spreaders it is very important that spreaders be kept square with ridge.

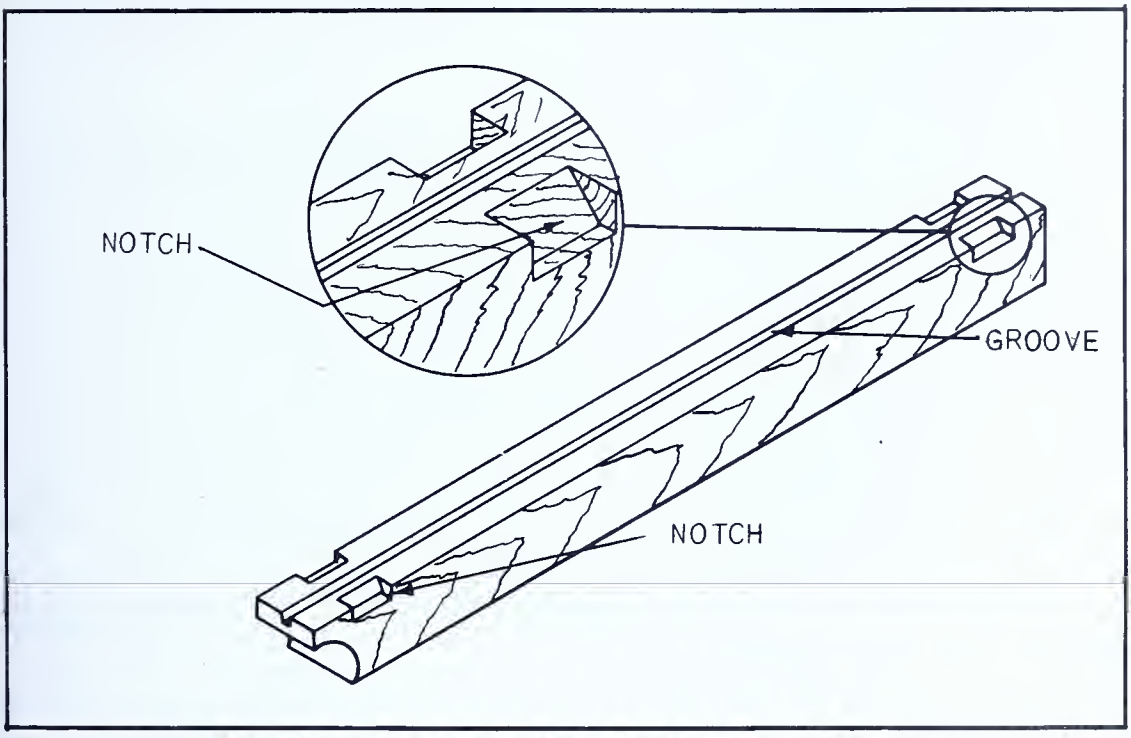


FIG. 246 — *Notches in Spreaders for Cover Battens*

23. Cut ceiling to length so that it will meet near the center of each groove in each spreader.

    The top edge of each piece of ceiling must be cut in a bevel so that it will lay smooth in the rabbet of the ridge. See Fig. 247.

24. Fasten ceiling to battens with 6-penny common galvanized nails. Face nail ceiling with 4-penny common nails.

25. Trim ceiling off so as to leave a $\frac{1}{2}$″ projection over the side of the boat.

26. Make a template to fit down snugly over the ridge and about 1″ over the ceiling on each side. See Fig. 247.

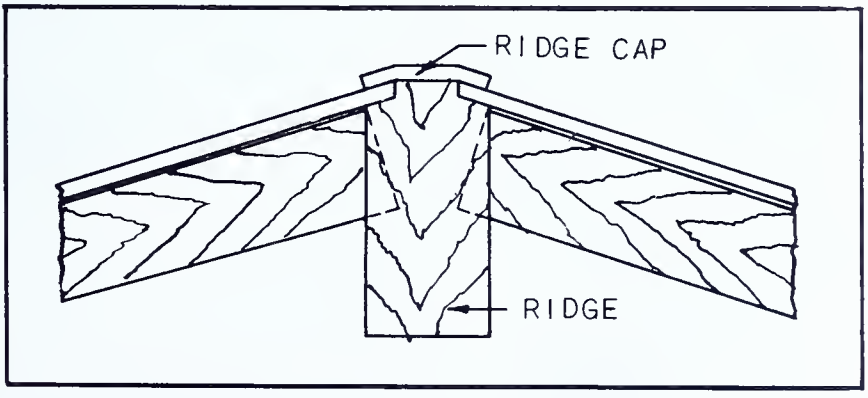


FIG. 247 — *Covers and Ridge Cap*

27. Lay off lock ridge from this template.

28. Cut lock ridge to shape.

29. Cut a section out of the ridge and lock ridge where boat falls go through the covers. This cut will be between the saddles. Also notch out covers for boat falls.

    This will not effect the strength of the ridge as it will be supported by a saddle on each end.

30. Drill 5/16″ holes for staples into ridge about 4′ apart.

31. Drive staples down so that they will project about 1″ above template for lock ridge.

32. Lay lock ridge against staples and mark for position of staples.

33. Cut holes in lock ridge for staples to come through.

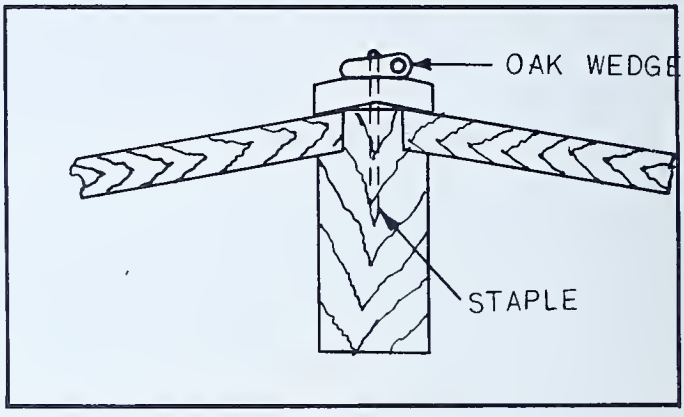


FIG. 248 — *Wedging Ridge Cap*

34. Set lock ridge in place.

    Staples should now project through lock ridge about 1″.

35. Make a set of oak wedges to fit staples.

36. Drive wedges in place in staples.

    This locks ridge in place. See Fig. 248.

37. Remove lock ridge and one cover.

38. Climb inside of boat while one cover is left on and make a template for a hook to fasten to the under side of the covers, so that covers will be held fast under gunwales. See Fig. 249.

39. Cut hooks to shape.

40. Fasten hooks to the cover with No. 12 x 2″ F. H. brass screws.

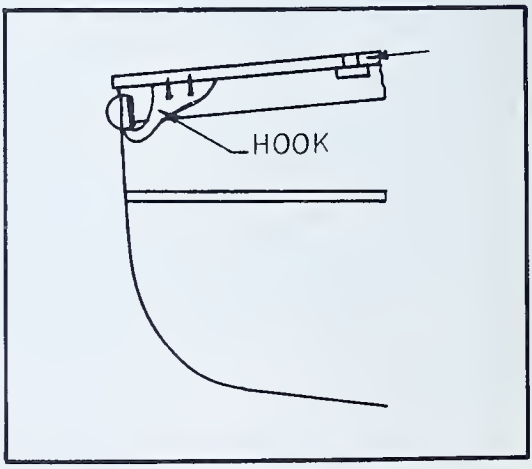


FIG. 249 — *Locking Hook for Covers*

QUESTIONS

1. Why are grooves cut in spreaders?
2. What piece holds the entire cover assembly in place?
3. Why are the covers made in sections?
4. How is the length of the ridge pole determined?
5. Where is the length of the spreaders found?
6. Explain the uses of the notches in the ridge pole.
7. Why are templates necessary for cutting material to shape?
8. Explain the purpose of the saddles.
9. State the procedure for obtaining the position of the saddles.

JOB SHEET NO. 25
MAKING PUDDING BOOMS FOR LIFEBOAT PROTECTION

General Information

Pudding booms are used to hold the lifeboats in an outboard position while the ship is at sea. When the lifeboats are in this position the crew has easy access to the boat and a minimum amount of work is required to lower lifeboats into the water. See Fig. 251.

Having the lifeboats in the outboard position is a war-time regulation for cases of emergency, such as when the ship is torpedoed. This practice has saved many lives.

Pudding booms are spars cut to a length 36″ greater than the spread of the davits. They are approximately 8″ in diameter at the center and taper to 5″ in diameter at each end. See Fig. 250.

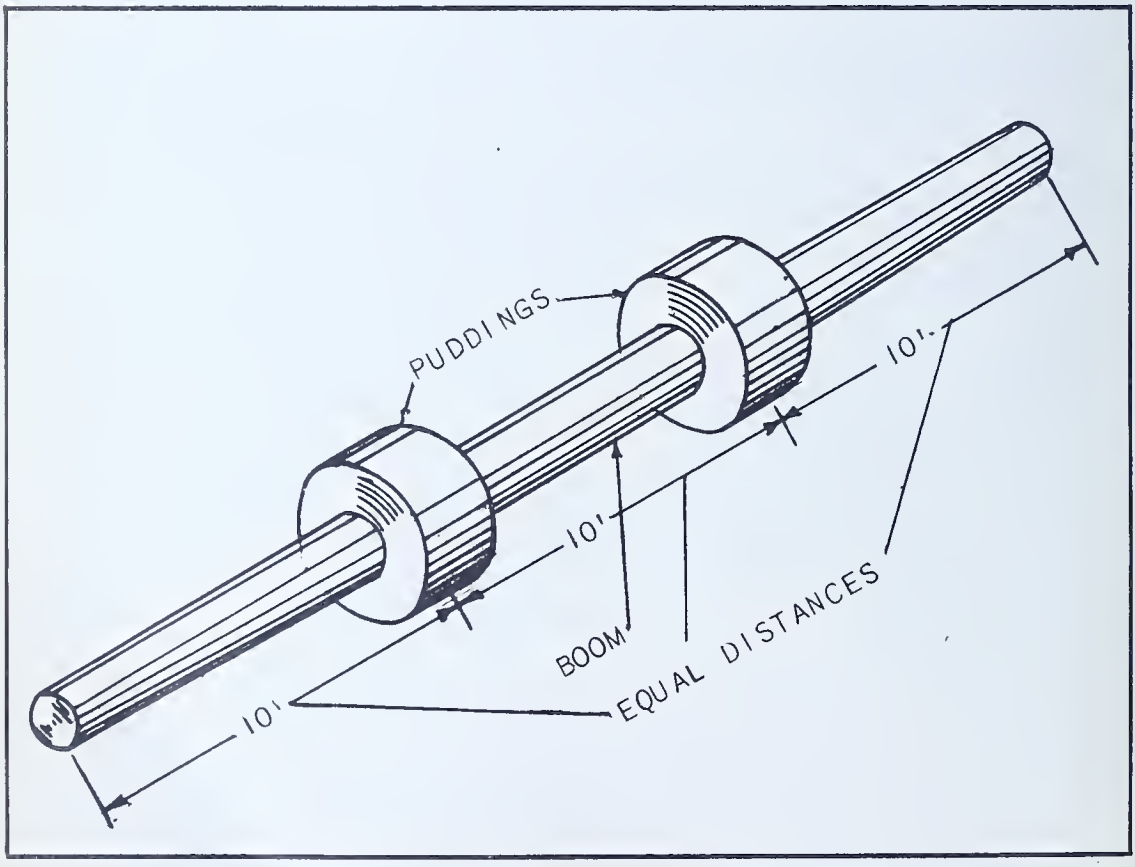


Fig. 250 — *Pudding Boom*

Pudding consists of a canvas boot filled with old rope, rags, sawdust, etc. The puddings are spaced about one third the length of the boom from each end. See Fig. 250.

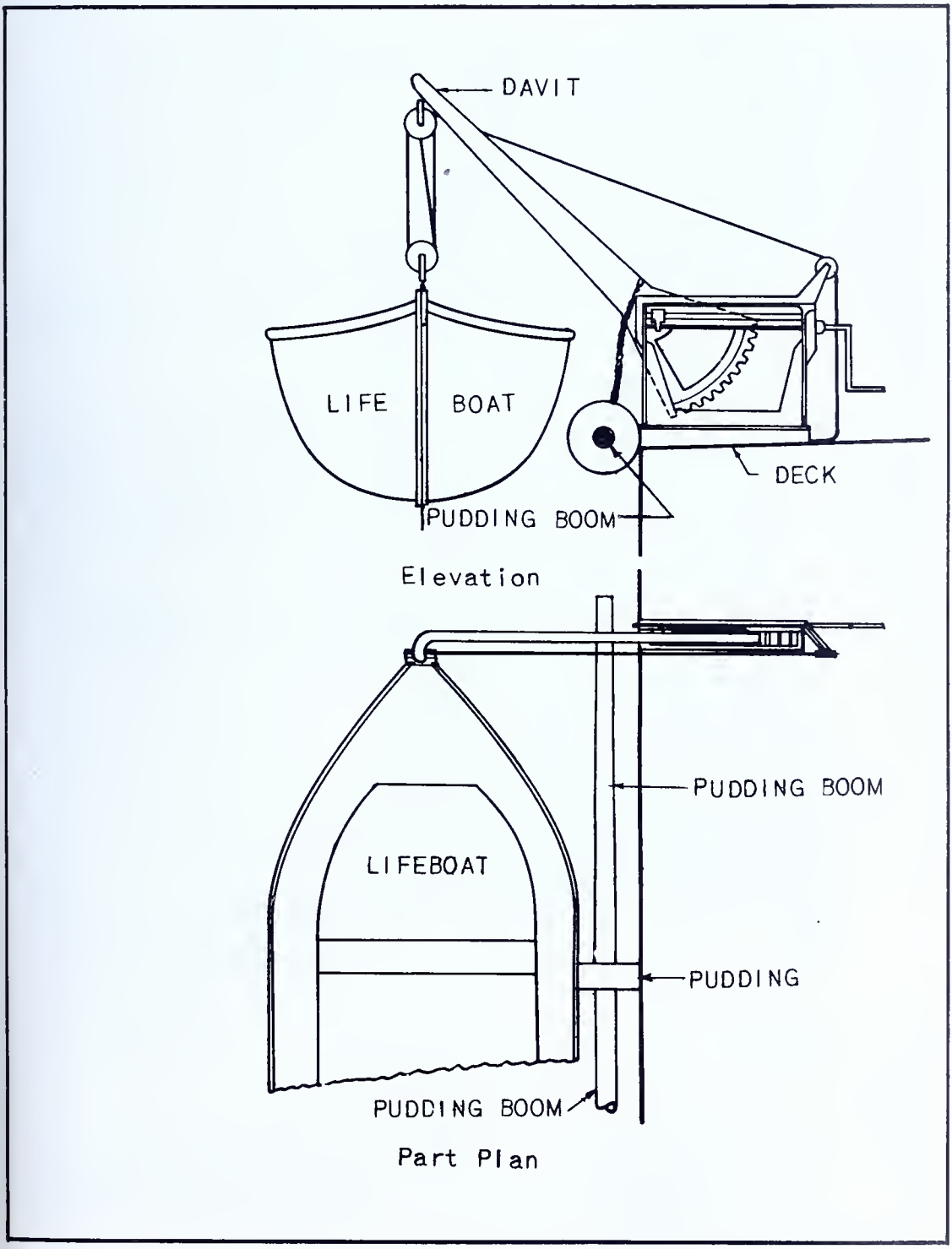


FIG. 251 — *Plan and Elevation of Davits and Lifeboat*

The pudding booms hang in position with a rope attached to each end and they are lashed to the desired height from the lifeboat davits.

Tools and Equipment	Materials
1. Chalk line	Timber for boom
2. Axe	Canvas
3. Adz	Tacks
4. Jack plane	

PROCEDURE

1. Measure the center-to-center distance between davits.
2. Obtain a timber 36″ longer than center-to-center distance of davits and approximately 8″ square.
3. Divide entire length of timber into three equal parts.
4. Taper the outer thirds from 8″ to 5″. (The 5″ dimension is on the ends of the timber.)
5. "Eight- and sixteen-square" the timber as shown in Fig. 203 to form the spar.
6. Paint, and deliver spar to rigging loft to have the puddings installed.

QUESTIONS

1. **Explain the purpose of pudding booms.**
2. **Why should the spar be longer than the distance between the davits?**
3. **How are the puddings made and what materials are used?**
4. **How are the pudding booms secured in position?**

JOB SHEET NO. 26
BUILDING AND INSTALLING A FORE-AND-AFT GANGWAY

General Information

The fore-and-aft gangway, Fig. 252, is a walkway extending from the poop deck to the forecastle deck. As the sea often washes over the main deck of a tanker, it provides a means of getting from one end of the ship to the other above the water.

The structural work is made of steel, and is covered with wood decking, spaced approximately ½" apart. The purpose of the decking is to prevent slipping which often occurs when walking on wet steel.

Sometimes the wood decking is bolted directly to steel plates permanently provided for this purpose, or the decking may be bolted to portable plates which are fastened at a few points to hold the section in place.

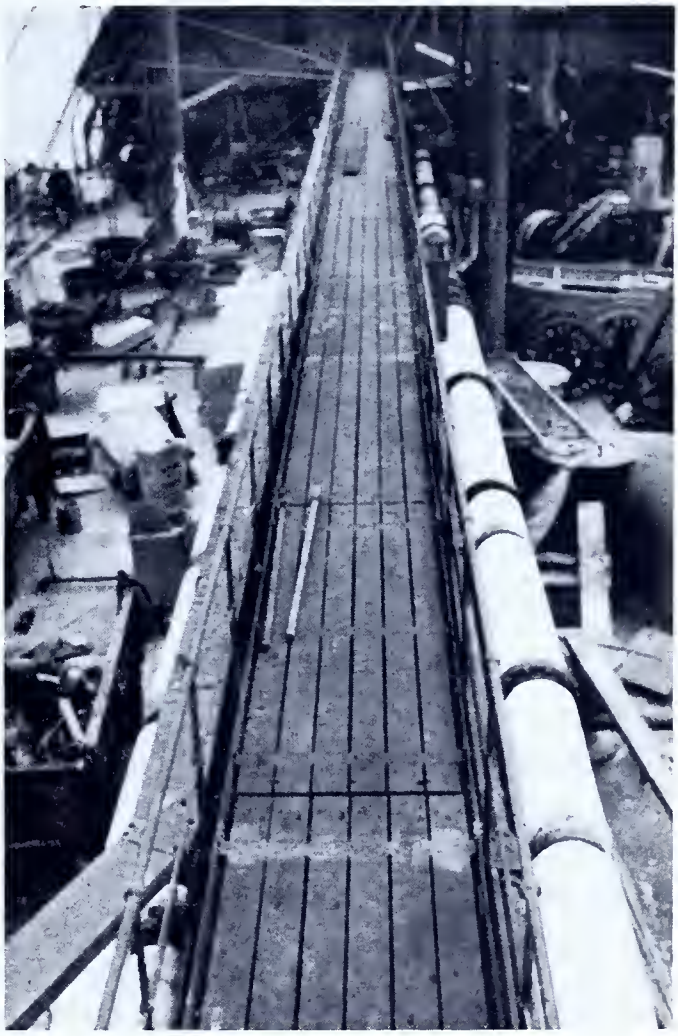


Fig. 252 — *Fore-and-Aft Gangway*

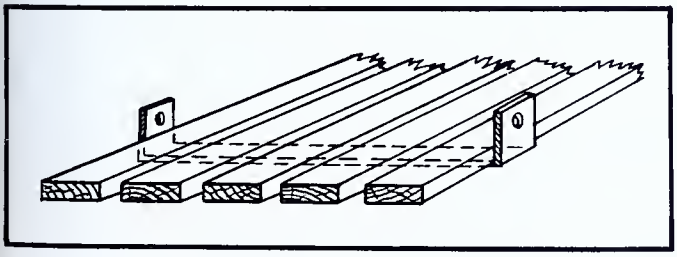


Fig. 253 — *End View of Gangway*

Both methods are used, but the latter is preferred. When repairs are necessary a whole section can be removed by loosening a few fastenings. Figure 253 shows the beginning of a gangway which is bolted to steel plates.

Tools and Equipment

1. Air drilling machine
2. Drills
3. Adjustable wrenches
4. Chalk line
5. Hand saw
6. Hatchet
7. Chisel

Materials

Lumber

PROCEDURE

1. Obtain length to cut stock from prints.
2. Cut and place stock lengths into position on the steel framework previously erected by the shipfitter. See Fig. 252.
3. Space as required with spaced blocks.
4. Lay out holes from steel framework.
5. Drill and bolt into position.

QUESTIONS

1. **What is the purpose of the fore-and-aft gangway?**
2. **Why do we space the planks?**
3. **What is the purpose of the flat bar?**
4. **Which type of gangway planking is preferred, permanent or portable?**
5. **How are the planks fastened to the steel framework?**

JOB SHEET NO. 27
*BUILDING STOREROOMS AND INSTALLING SHELVING

General Information

All food supplies that are not perishable are kept in the storeroom. See Fig. 254. The storeroom is usually built under the shelter deck and as near the galley as possible. Storerooms vary in size. Some storerooms have a trap door in the deck overhead and have steps from the trap-door opening leading down into the room.

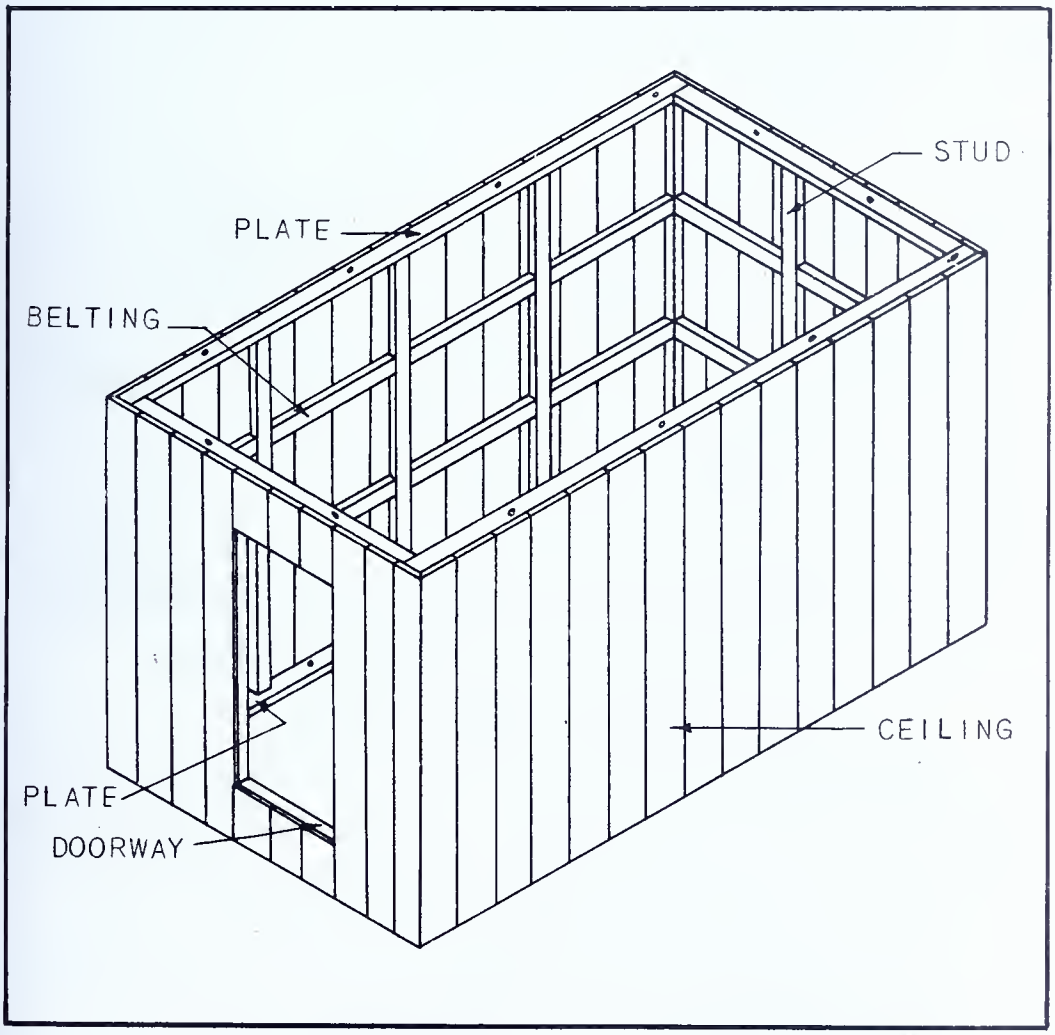


Fig. 254 — *Storeroom*

*Adapted from "Ship Carpentry," Alabama State Department of Education.

Tools and Equipment

1. Saw
2. Hammer
3. Plane
4. Square
5. Bevel
6. Chisels
7. Mallet
8. Brace
9. Bits

Materials

2″ x 4″, 2″ x 6″, or 2″ x 8″ furring
1″ x 6″ ceiling
3″ x 3″ x 8′-0″ post
1″ x 12″ shelving
1¼″ x 3″ crosspiece
1″ x 3″ slots
½″ x 2½″ carriage bolts
6-, 8-, or 10-penny common nails

NOTE: Lumber generally in use for purposes and sizes specified above is pine or cypress. Fir lumber is sometimes used for furring.

PROCEDURE

1. Determine the location of the storeroom. See the blueprint.
2. Determine the size of the storeroom. See the blueprint.
3. Cut two-by-fours to the length of the storeroom for sills.
4. Have welded to the deck the clips to which the sills are to be bolted.
5. Drill holes in the two-by-fours and bolt them to clips.
6. Cut plates to the length and width of the sills.
7. Mark on the floor the position of the overhead deck-beam plates so that the edges of the storeroom sills can be located plumb with the plates.
8. Drill holes in the deck beams and bolt the plates in position.
9. Measure the distance between the plates and the sills.
10. Cut the studs to this length.
11. Space the studs to 2′ centers except at the door opening and toenail the studs in place.
12. Cut belting (Fig. 254) to the width between the studs.
13. Line up and toenail the belting in place.
14. Measure the vertical height for ceiling material.
15. Cut the ceiling material to this length.
16. Attach vertical ceiling with common 8-penny galvanized nails.

17. Measure height and width of the door opening.
18. Cut ceiling material to the proper vertical height.
19. Cut three crosspieces 1¼" x 3", the width of the door. See Fig. 255 for battens.
20. Lay the 3 crosspieces (battens) on the floor and lay ceiling across them. See Fig. 255.
21. Fasten in place with 8-penny common nails.
22. Put on diagonal ceiling. See Fig. 255.
23. Fasten door in opening with strap hinges.
24. Build shelves.
25. Build grating.

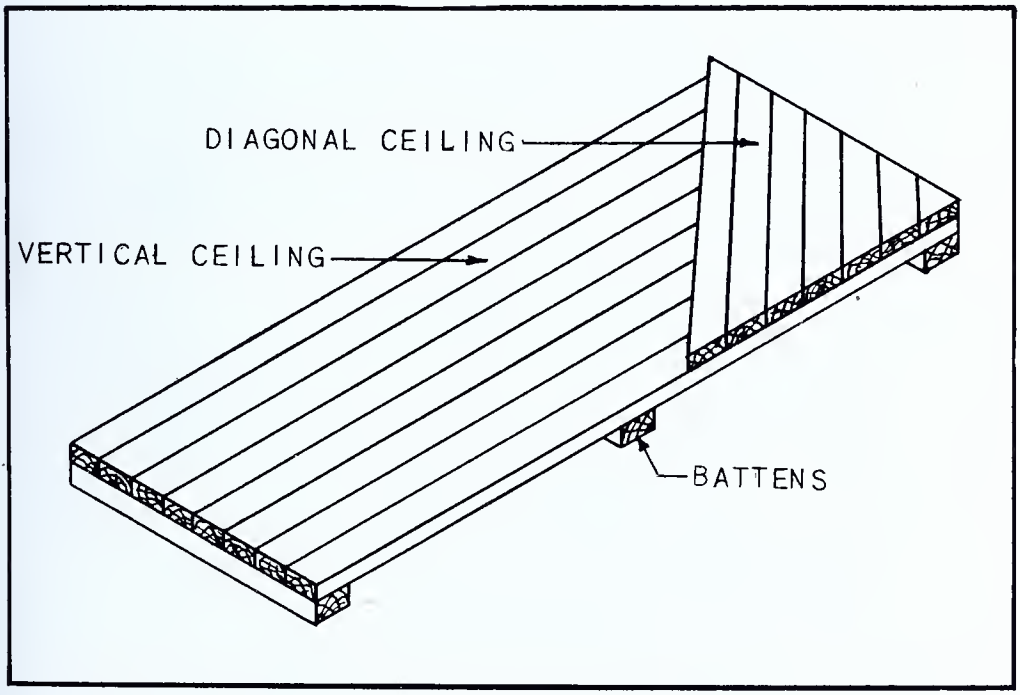


FIG. 255 — *Storeroom Door*

Shelving for Ship's Gear

STOREROOM SHELVING

The shelving built in the forepeak (Fig. 256) is for the purpose of storing the ship's gear, such as rope, blocks, wire cables, distress signal balls, etc.

The height of shelving is determined by the height between decks and the number of shelves required.

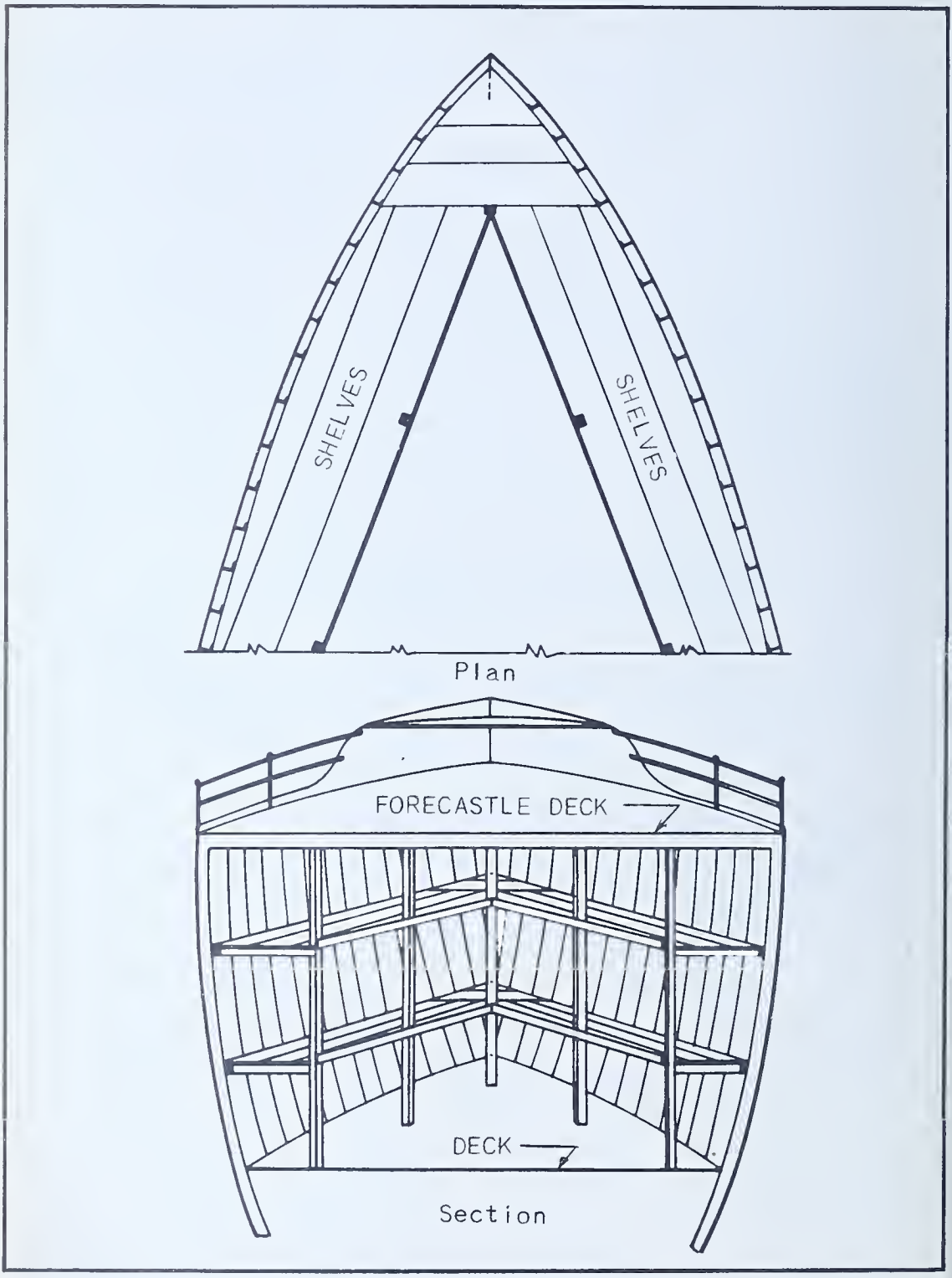


FIG. 256 — *Shelving for Ship's Gear in the Forepeak*

Battens are bolted to the vertical frames at the height needed. 4″ x 4″ studs are cut to length and fastened to the deck and deck beam by means of clips on bolts.

2″ x 6″ stringers are then nailed to the stud and batten, forming horizontal members to which the shelving boards can be spiked.

The shelving boards are usually 2″ x 12″ spruce plank with a 2″ x 6″ nailed along the front and parallel to the shelving.

QUESTIONS

1. **What is the purpose of a storeroom?**
2. **How are the sills fastened?**
3. **Explain the use of belting.**
4. **Why are galvanized nails used?**
5. **Why is diagonal ceiling put on a storeroom floor?**

JOB SHEET NO. 28
BUILDING ROPE GRATING

General Information

Grating is a false floor made by nailing batten slats to sleepers or ties. The purpose of the rope grating is to provide a place for cleaning and drying the ropes. The grating is raised from the deck to allow water used in cleaning the rope to drain off and to permit a free circulation of air through the rope when drying. See Fig. 257.

It is common practice to make the grating in one solid section, and then saw the grating into as many sections as is necessary for easy handling when the grating is removed.

Grating slats are $1\frac{3}{4}''$ x $2\frac{3}{4}''$ in size.

Fig. 257 — *Rope Grating*

Tools and Materials

1. Chalk line
2. 6′ rule
3. Saw
4. Square
5. Hammer
6. Bevel
7. Nails
8. Clamps

Preparing the Supports

Before the ship carpenter begins this job the shipfitter places the angles which form the stand for the grating. See Fig. 258. The shipfitter also welds angles between the stiffeners along the shell of the ship. These angles support the ends of the grating strips.

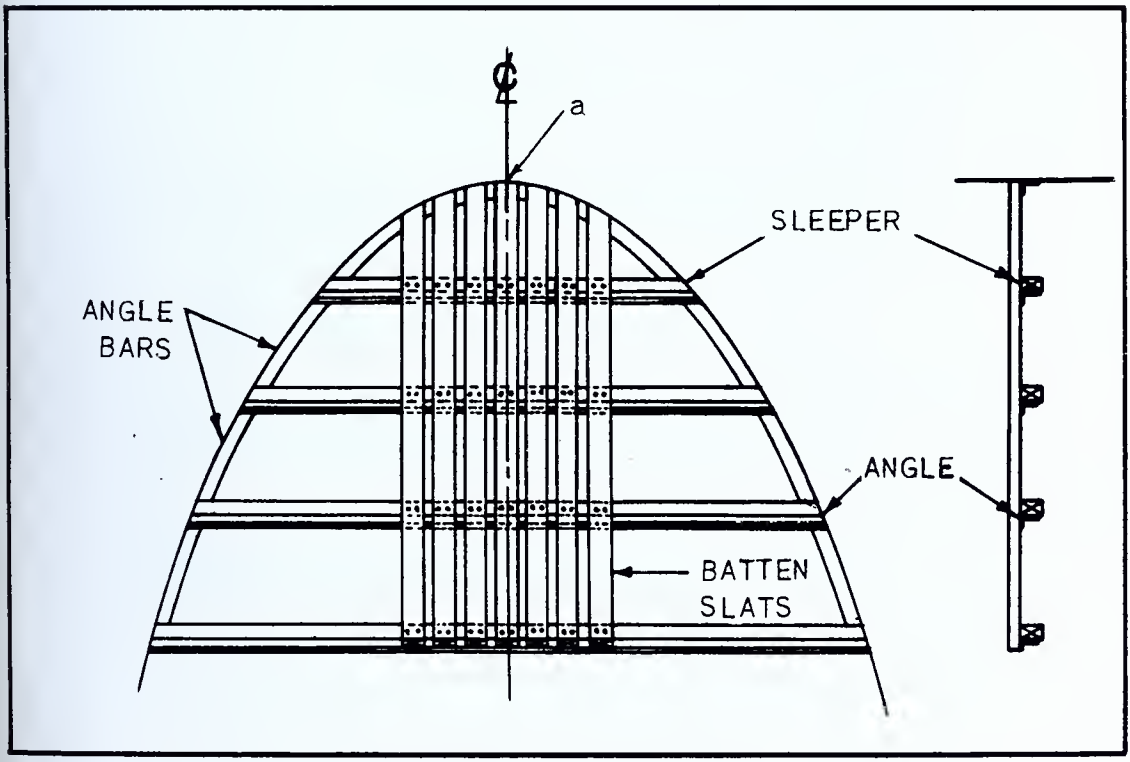


Fig. 258 — *Battens and Grating*

Procedure

1. Measure the length of the nailing ties. (Take their measurement from the location on the deck).
2. Cut the nailing ties to the length found in step 1.
3. Clamp the nailing ties to the side of the angles, as shown in Fig. 258. Use C-clamps to hold ties in place. Clamping prevents the grating from sliding.

4. Locate and snap the center line of the grating on the sleepers. See Fig. 258.

5. Cut the center grating slat to proper length.
   Be sure one end of the grating is fitted to the curvature of the shell. See "a" in Fig. 258.

6. Lay and nail the center grating slat. See Fig. 258.

7. Cut, fit, and lay the remaining grating slats.
   Cut slats to fit the curvature of the shell, spacing them ½" apart.

8. Mark grating into convenient handling sizes.

9. Saw the nailing ties at the positions marked.

10. Remove sections and plane off any sharp edges.

11. Point the grating.
    "Pointing" is a long chamfer or bevel cut on the ends of the nailing ties to prevent sharp corners from catching when replacing grating.

QUESTIONS

1. **What is the purpose of rope grating?**
2. **Why is rope grating placed on a platform?**
3. **Why are grating slots placed 1¼" apart?**
4. **What is the advantage of cutting the grating into sections?**
5. **Why are the grating slots laid from the center to the outer shell?**

JOB SHEET NO. 29
MAKING VENTILATOR COVERS

General Information

Ventilator covers are for the purpose of blanking off or closing the ventilator trunks when the ship is in bad weather. See Fig. 259.

A ventilator cover consists of two pieces of circular wood. The smaller diameter fits snugly into the inside of the trunk (Fig. 260) with a 1/16" taper. The 1/16" taper permits the cover to enter the opening easily and also provides a neat fit when the cover is in place.

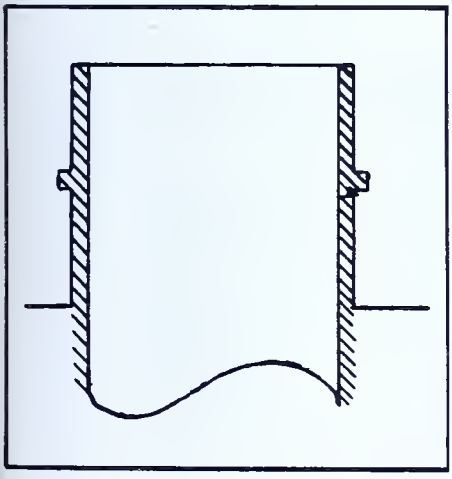


Fig. 259 — *Ventilator Trunk*

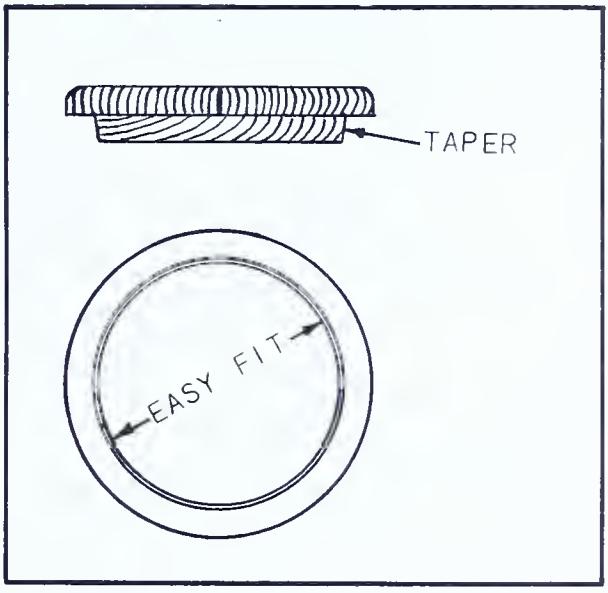


Fig. 260 — *Ventilator Cover*

The second diameter equals the outside diameter of the trunk (Fig. 261) and is screwed to the first or smaller diameter with the grain of the wood running in opposite directions.

The top edge of the second piece has rounded edges to eliminate wearing of the canvas boot.

A canvas cover or boot is lashed over both ventilator trunk and wood cover to make the trunk seaworthy. See Fig. 262.

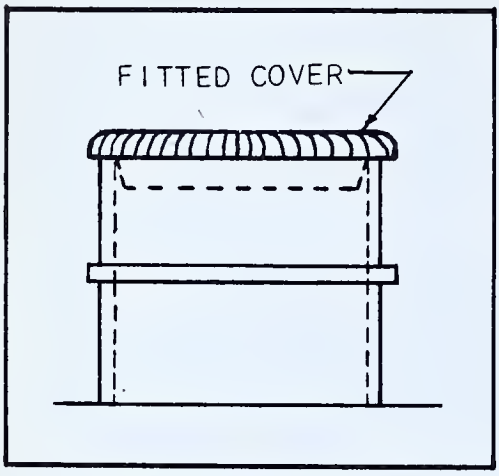


FIG. 261 — *Cover on Trunk*

Figure 263 shows a ventilator cowl installed on a ventilator trunk, after the ventilator cover has been removed.

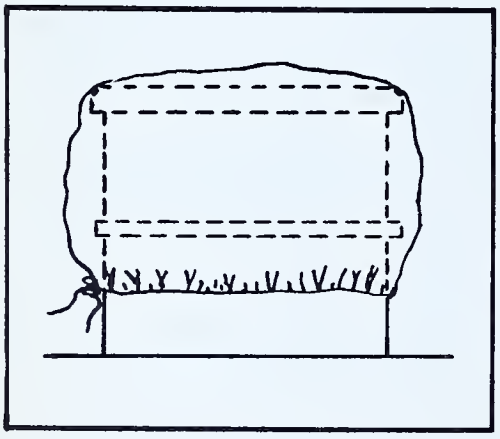


FIG. 262 — *Canvas Boot*

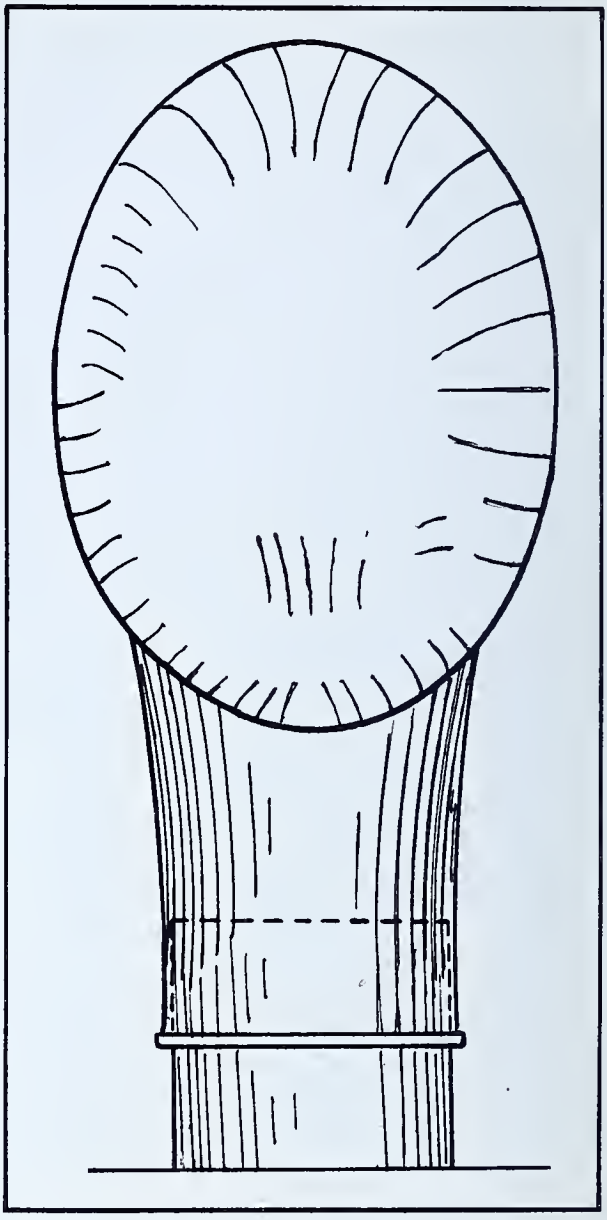


FIG. 263 — *Ventilator and Cowl in Place*

Tools and Equipment

1. Bandsaw
2. Hammer

Materials

Lumber
Nails
Canvas

PROCEDURE

1. Measure the inside and outside of ventilation trunk to determine diameter of the cover.

2. Cut the lower section to the inside diameter with a 1/16″ under cut on bevel.
3. Cut the top section to the outside diameter and round one edge.
4. Center top section over lower section with grains of wood crossed.
5. Nail into position.
6. Paint and deliver to the ship.

QUESTIONS

1. **What is the purpose of ventilator covers?**
2. **Why is the lower section beveled?**
3. **Explain the reason for the crossing of wood grains.**
4. **How does this cover make the trunk waterproof?**

JOB SHEET NO. 30
MAKING AND INSTALLING HAND RAILS

General Information

A hand rail is a large oval shaped railing placed on the pilot house bulwark, and similar bulkheads. It is made from first class oak, ash, teak or mahogany lumber; it is smoothly sanded and beautifully finished. See Fig. 264.

Fig. 264 — *Hand Rail at the Midship House*

Tools and Materials

1. 6′ rule
2. Square
3. Plane
4. Sandpaper
5. Saw
6. Brace and bit
7. Plug bit
8. Chalk line
9. Chisel
10. Scraper
11. C-clamps

PROCEDURE

1. Determine the location, size and shape of the rail from the blueprint.
2. Select suitable material.
   Material must be first class stock, free from knots.
3. Have the material surfaced and run through the sticker machine.
   The sticker machine cuts the rough stock into the desired shape of the hand rail.
4. Smooth the railing with a wood scraper and sandpaper.
5. Have the railing taken to the ship.
6. Scarf sections of railing together until the required length is attained.
   The scarf joint and the method of fastening is shown in Fig. 266.
7. Measure the exact length of rail. (Measure on the job.)
8. Cut the rail to length.
   If the ends of the rail do not butt against another member, cut a "return" on each end of the railing. This may be done with a plane, chisel and sandpaper.
9. Fit the rail in place.
10. Hold rail in position with C-clamps.
11. Fasten the rail to the metal bulwark.
    If the rail is bolted to the bulwark, the rail will have to be drilled, counter bored, bolted and plugged, as shown in Fig. 265.
12. Re-touch the scarf joints with a chisel, plane or scraper.
13. Sand and scrape the entire rail smooth.

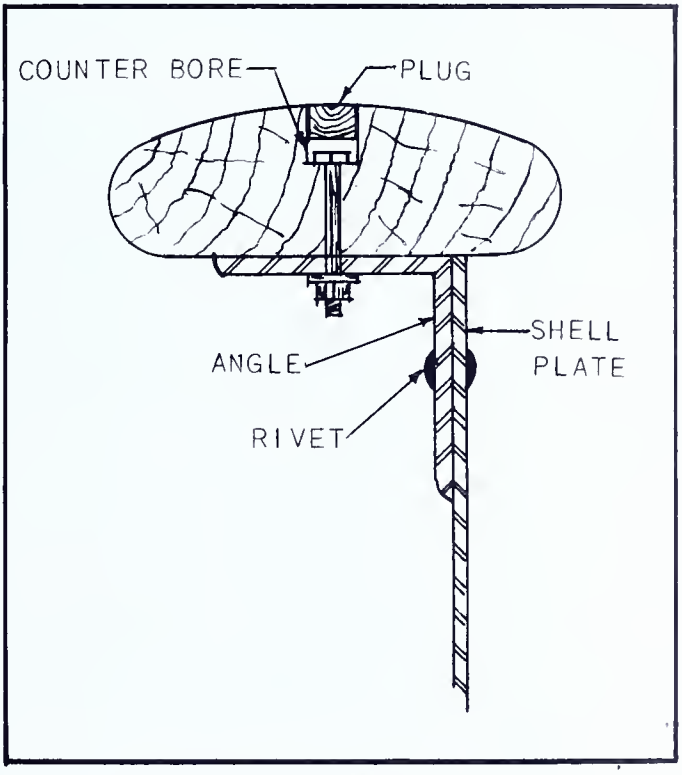


FIG. 265 — *Method of Attaching Hand Rail to Bulwark*

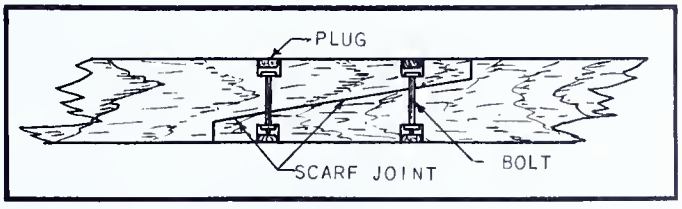


FIG. 266 — *Method of Scarfing Hand Rail*

QUESTIONS

1. Why is a scarf joint used instead of a butt joint on the hand rail?
2. Describe the procedure followed in making a scarf joint.
3. How is a scarf joint fastened together?
4. Are there any other joints used on hand rails?
5. Explain how a hand rail is fastened to a ship.

JOB SHEET NO. 31
INSTALLING FENDER LOGS

General Information

Fender logs are placed on small ships, barges, and tug boats to relieve the chafing and bumping when pulling in alongside a pier or ship. Fenders are usually constructed of wood, although sometimes they are made up of hollow steel tubing welded in half-section to a steel shell.

The wood fenders are fastened in two ways, either by bolting horizontally through the shell and fender log (Fig. 267), or by bolting vertically through fore-and-aft angle bars and fender logs as shown in Fig. 268.

Types of Fenders

Wood fenders can be of two types, either in one solid piece or in two pieces. The latter is often considered the better, since the outside or wearing piece can be renewed with a minimum amount of labor. The solid type is usually bolted through the shell. The most popular fender is the two-piece type.

Installing One-Piece Fender Log (Fig. 267)

Tools and Equipment

1. Air drilling machine
2. Drills
3. Sledge hammer
4. Pocket knife
5. Spud wrench
6. Plug bit

Materials

Lumber
Bolts and washers
Flat bar
Countersunk spikes
Tarred felt
Grommets
Red lead paint

Procedure

1. Fit the log to the outside shape of the shell.
2. Lift the holes in the shell and lay out in the inboard side of the fender log.
3. Drill the holes through the log. Counterbore the outboard side of the log to allow for a washer and the head of the bolt, as well as for a wood plug.
4. Tack tar felt to the log. Also tack a lampwick grommet around each bolt hole between the wood and the steel shell. The lampwick grommet is very

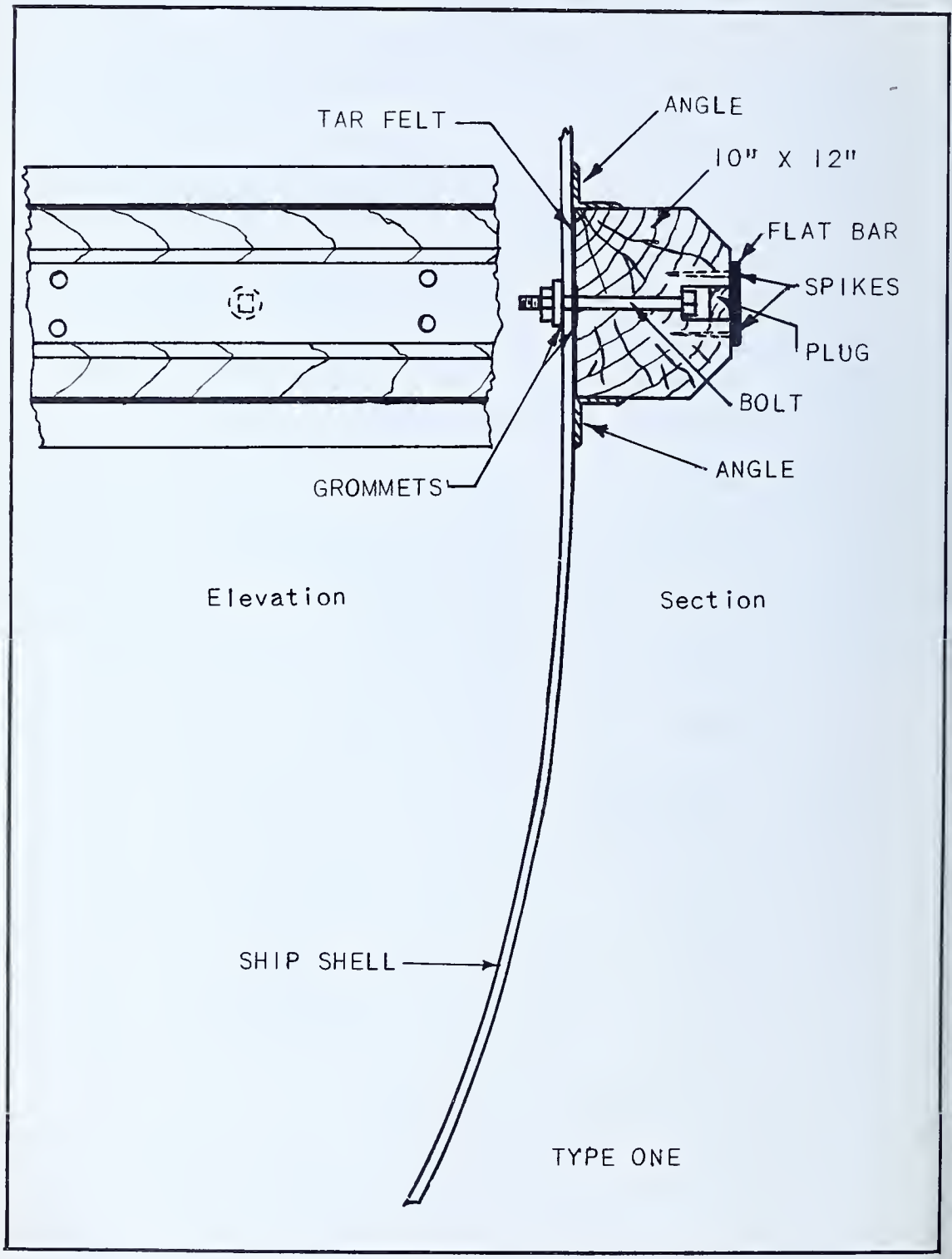


FIG. 267 — *Fender Logs Bolted Horizontally*

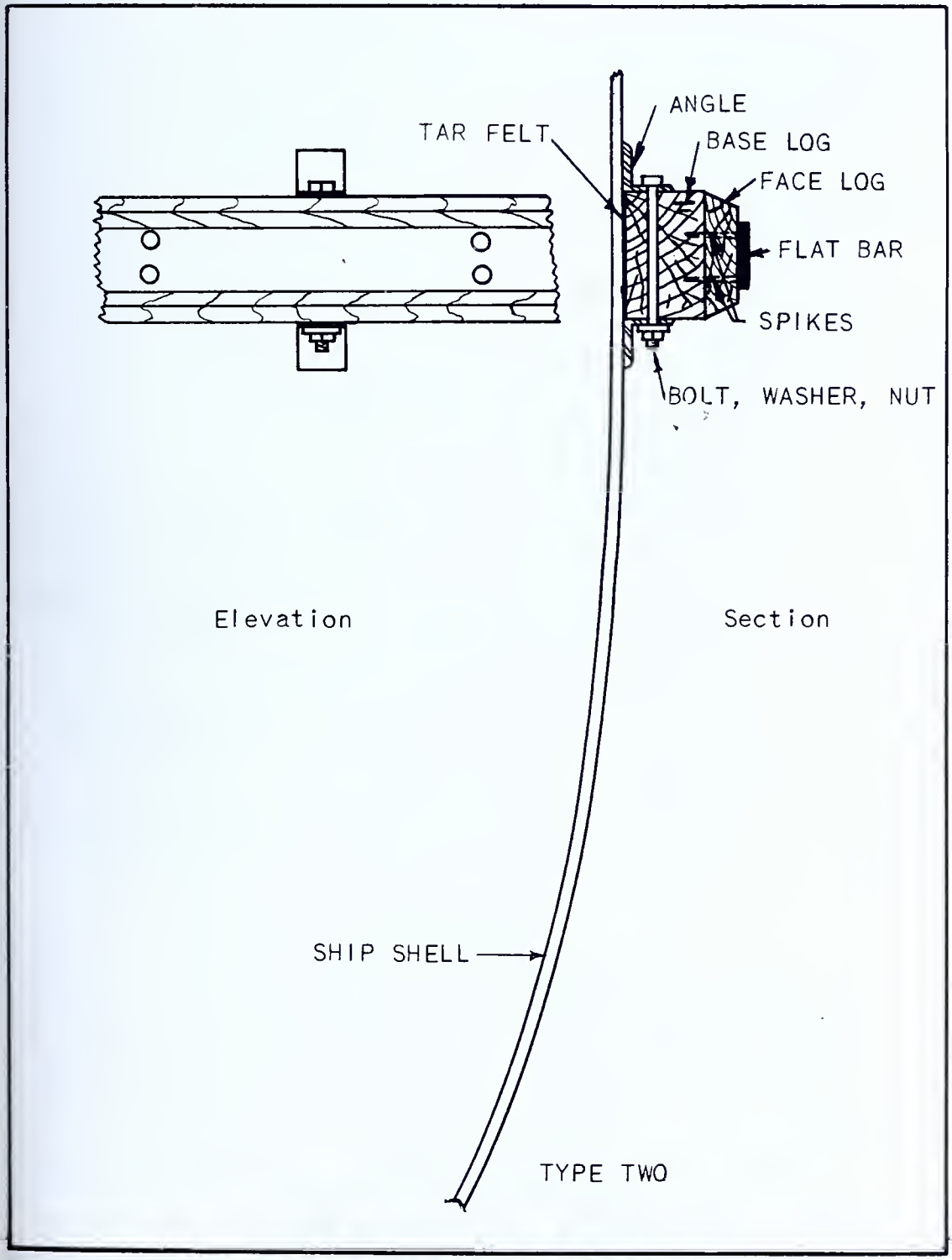


FIG. 268 — *Fender Logs Bolted Vertically*

important because it keeps the water from entering the bolt hole. See Fig. 267.

5. Place and bolt the fender log into position, placing a grommet between the inside shell and a steel washer. The inside grommet is an extra precaution against leaks.
6. Spike a steel flat bar to the outside face of the log with 5/8" counter sunk spikes.

Installing Two-Piece Fender Log (Fig. 268)

PROCEDURE

1. Fit the first section or base log to the shell, outside.
2. Tack tar felt to the shell side of the log.
3. Place the base log between the two angles previously welded to the ship shell.
4. Drill holes vertically through the top angle, the base log and the bottom angle, with one operation. See Fig. 268.
5. Spike the face log to the base log. Use 40-penny spikes.
6. Place steel flat bar on the outside of the face log end. Using the flat bar as a template, drill holes for the spikes into the face log.
7. Spike the flat bar to the outside of the face log with 5/8" counter sunk spikes.

QUESTIONS

1. **Explain the use of fender logs.**
2. **Name the different types of fenders.**
3. **Explain the use of vertical bolts.**
4. **How are horizontal bolts installed?**
5. **Which type of bolting is preferred?**
6. **Why is a steel flat bar used on the outside of a wooden fender?**

JOB SHEET NO. 32
CHOCKING SPARE PARTS

General Information

I. Chocking Spare Piston

Practically all ships that are powered with a diesel engine carry a spare piston.

The piston must be securely fastened to a firm support on deck. The piston is usually stored in the engine room for easy access. It must be

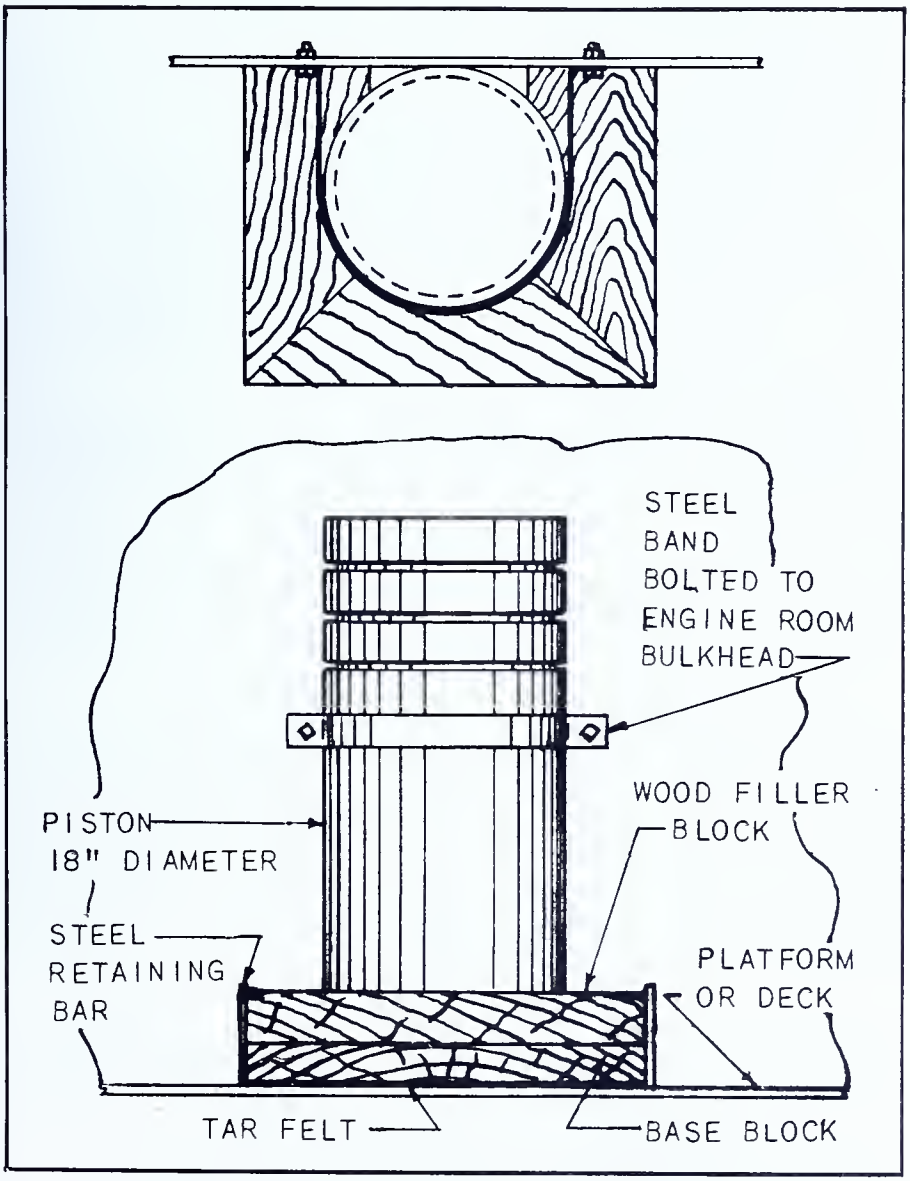


Fig. 269 — *Spare Piston Chock*

stored so that it occupies the least amount of space, for all space on a ship is valuable. It has been found that the vertical position shown in Fig. 269 is the most suitable.

Tools and Equipment	Materials
1. Band Saw	Flat bar
2. Brace and bit	Lumber
3. Hammer	Bolts and washers
4. Adjustable wrench	Tarred felt

PROCEDURE

1. Place on the bulkhead or stiffener, previously prepared steel supports or steel brackets to take the weight of the piston.
2. Place a sheet of tar felt to extend four inches beyond the piston on three sides. See Fig. 269, top view.
3. Place a piece of 4″ pine or oak on top of the tar felt (the same size.)
4. Place other 2″ pieces of wood on top of the first piece. Miter the corners as shown in Fig. 269 top view to fit even with the outside all around.
5. Lay out the diameter of the piston on the three mitered pieces. Cut out as shown in Fig. 269.
6. With 20-penny spikes fasten the three mitered pieces to the foundation pieces.
7. Procure a previously prepared steel band which fits around the piston.
8. Fit the steel band around the piston and against the bulkhead, drill, and bolt fast as shown in Fig. 269.

II. CHOCKING SPARE BLADES AND ANCHOR CHOCKS

Chocks for spare blades and spare anchors are shaped pieces of wood which fit under these members to keep them off the steel decks. They are made and fastened similarly to the spare piston method. Tar felt is always placed between the steel deck or bulkhead and the wood chock. The tar felt prevents rusting and rotting of the wood.

QUESTIONS

1. **What is the meaning of chocks as used on this job?**
2. **Why is tar felt used between steel and wood?**
3. **How are the two layers of wood fastened together?**
4. **Explain the purpose of the steel band.**

JOB SHEET NO. 33
MAKING A FOG BUOY

General Information

Purpose of a Fog Buoy

The fog buoy is a wooden device which is pulled through the water by means of a tow rope about 1600 feet long fastened at the stern of the ship. On foggy days another ship can follow the first ship by the spray thrown up by the fog buoy. The fog buoy is necessary for keeping all ships on the same course and for avoiding accidents and collisions in convoys.

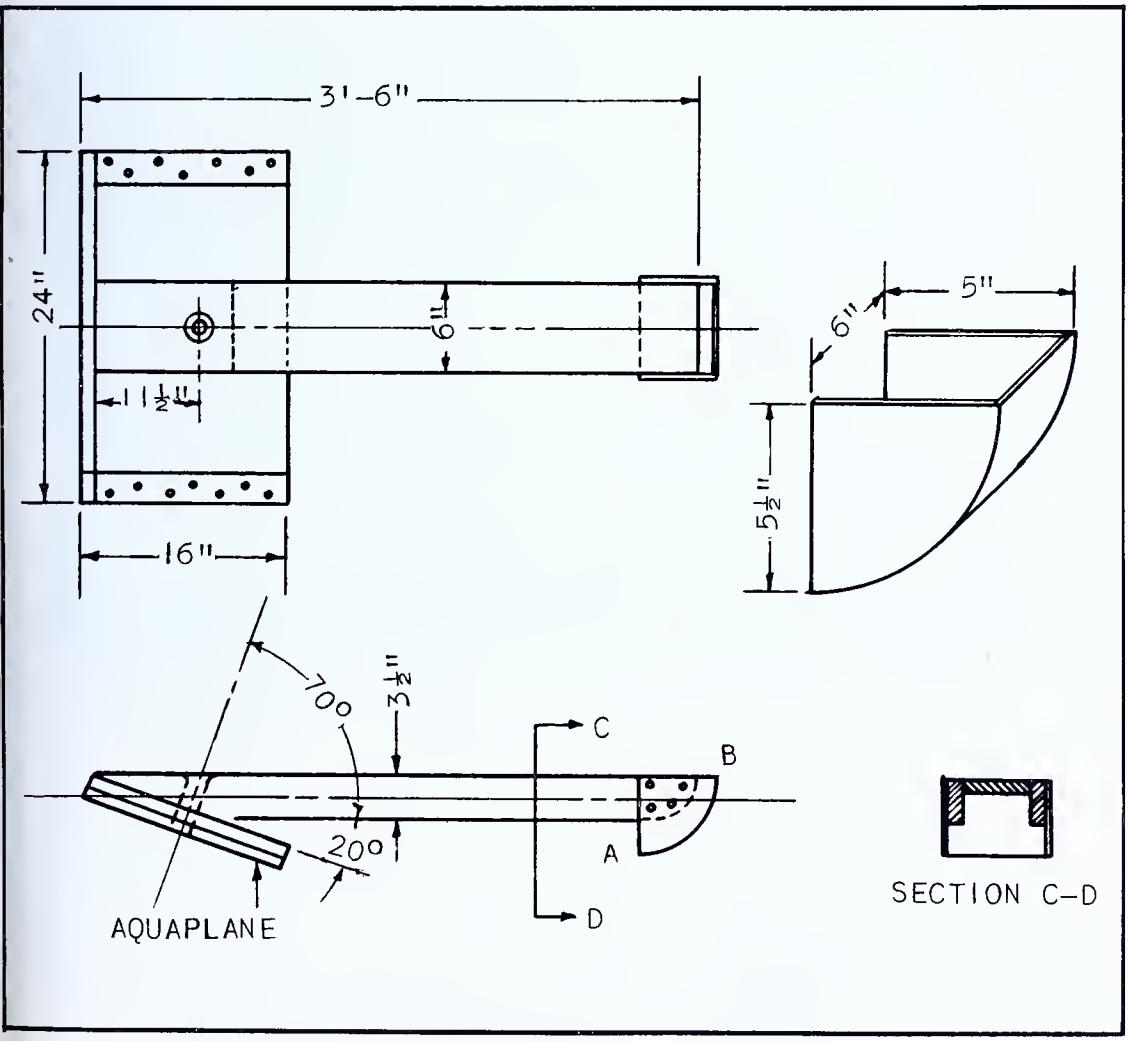


Fig. 270 — *Plan and Elevation of a Fog Buoy*

The Fog Buoy in Use

The water is forced through the opening at "A" to shoot out at "B". Since the opening at "A" is about 5 times as great as at "B", the water forms a plainly visible spray at point "B".

Tools and Equipment	Materials
1. Hand saw	Lumber
2. Brace and bit	Sheet metal
3. Screwdriver	Bolts
4. Adjustable wrench	Wood screws
5. Protractor	

Procedure

1. Cut the different sizes of wood required from measurements on the print.
2. Screw battens to wood as shown in the print.
3. Have the sheet metal chutes made to the given measurements.
4. When fastening the different parts together, follow the blueprint very carefully.
5. Bore hole for towing cable.

QUESTIONS

1. **What is a fog buoy?**
2. **Why is the chute installed on the end?**
3. **Explain the action of a fog buoy when being towed through the water.**

JOB SHEET NO. 34
BUILDING LAUNCHING WAYS

General Information

When the hull construction of the ship is complete, the ship is slid into the water on greased skids. These skids are made from heavy 12″ x 12″ timbers and are called launching ways. Two types are necessary: the ground way, and the sliding way. The ways are made up in (39 foot 10 inch) sections before placing. See Fig. 271.

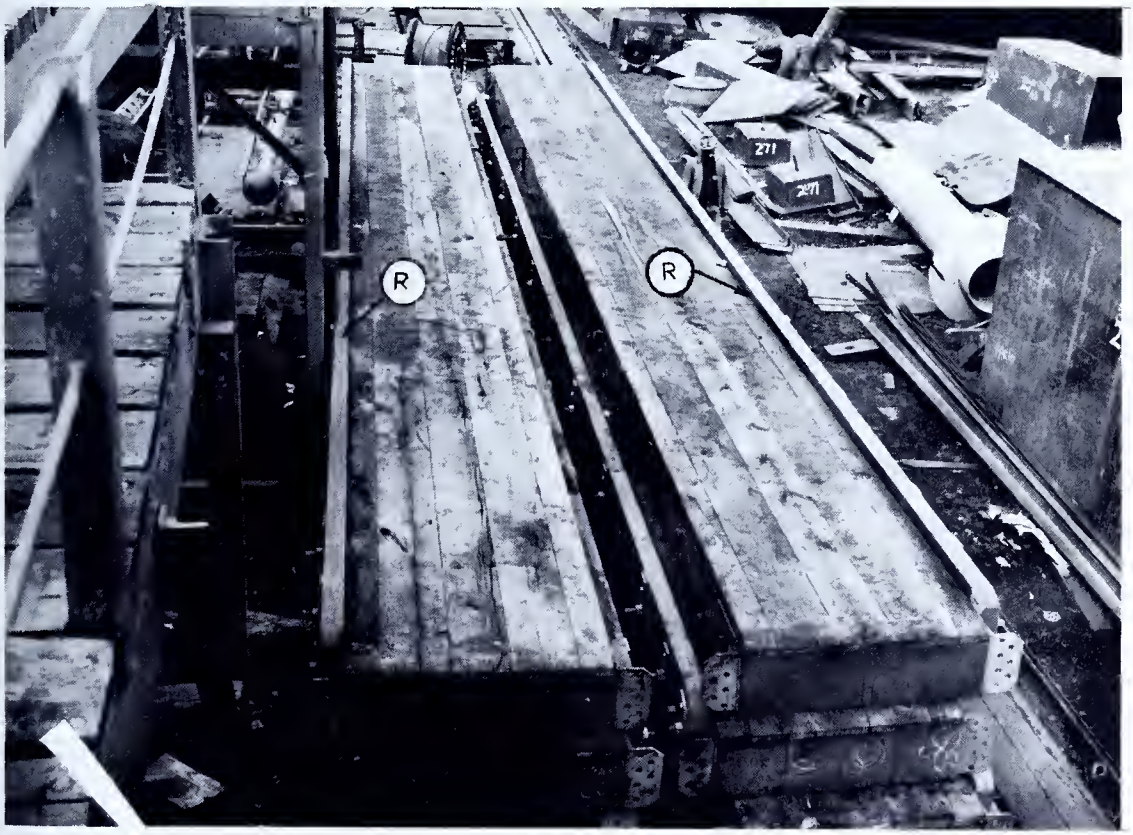


Fig. 271 — *Launching Ways Piled up Ready for Placing Ribband Strip Shown at "R"*

Tools and Materials

1. Tape
2. 6′ rule
3. Square
4. 2-man crosscut saw
5. Adz
6. Plane
7. Wrenches
8. Boring machine
9. Auger
10. Bolts
11. Chisel

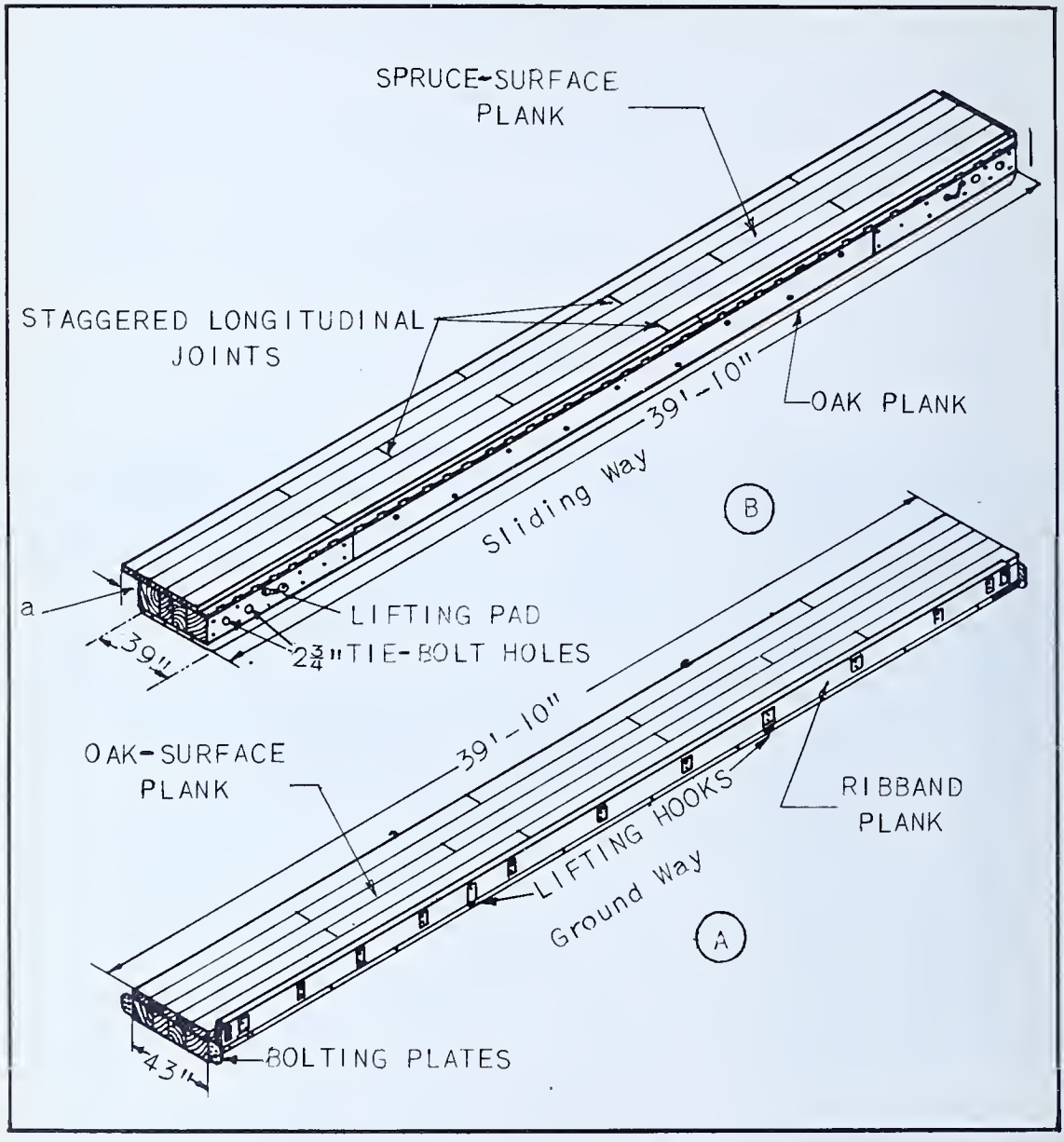


Fig. 272 — *Launching Ways*

Building Ground Ways

Procedure

1. Place four timbers side by side on skids.

   Two 12″ x 12″ timbers and two 10″ x 12″ timbers 40 feet long are used to make the ground way. They are placed on skids which raise the timbers to a convenient working height. See Fig. 272.

2. Paint the timber surfaces which are to fit together.

3. Clamp the timbers tightly together.

4. Measure and mark the lengthwise mid-point of the way.

5. At the mid-point of the way, measure down the side 3″ to locate the center of the hole for the eye bolt.

6. Mark the remaining holes.
   Holes are spaced two feet apart and staggered. See Fig. 272.

7. Bore 1-5/16″ holes through the four timbers.
   The bit is sighted for straightness. Follow the procedure shown in Fig. 273.

8. Place and tighten bolts in the bottom row of holes. Place washers under heads.

9. Cut off the ends of the way to the proper length.

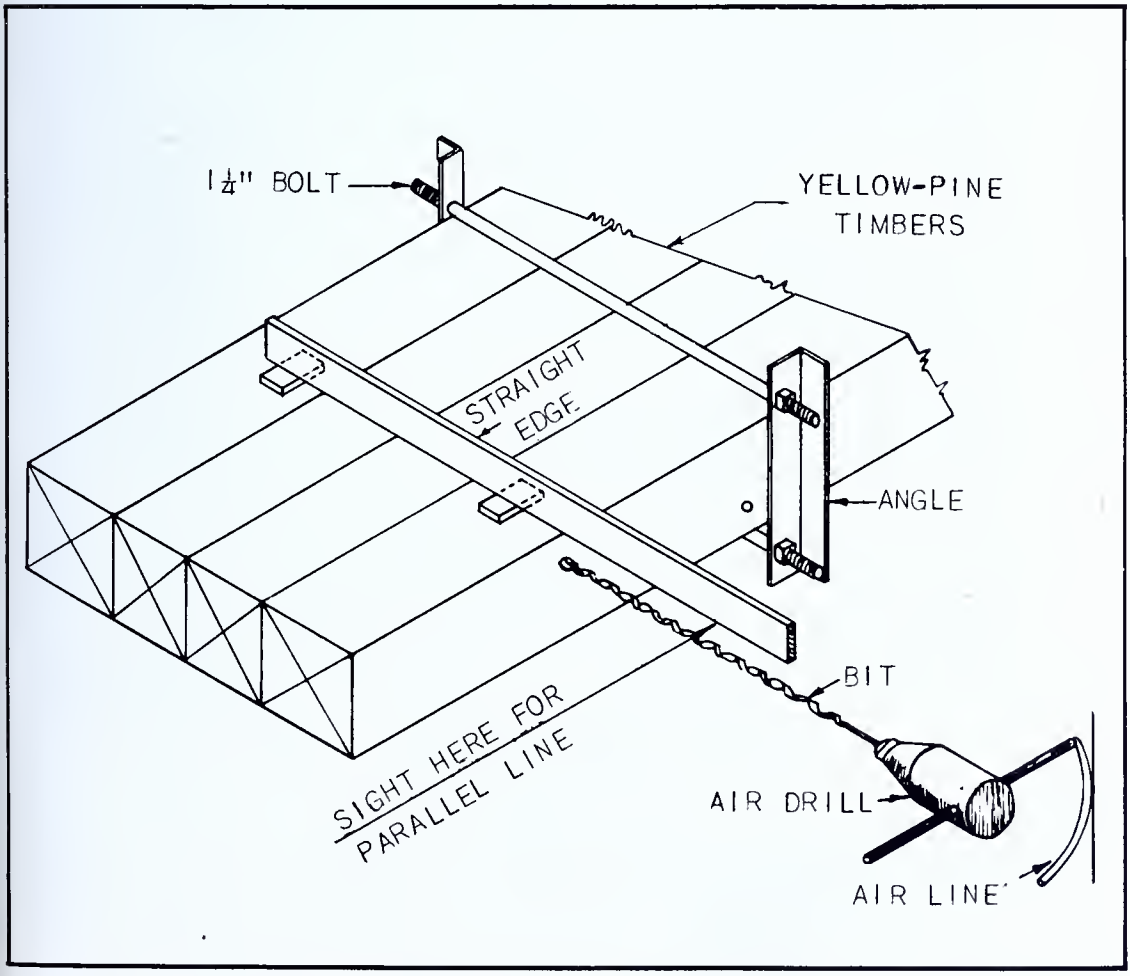


FIG. 273 — *Method of Sighting a Drill for a Straight Panel Hole*

10. Place the end plates. See Fig. 272.
    (a) Locate in exact position. (Even top and bottom.)
    (b) Clamp into position.
    (c) Bore the holes.
    (d) Place and tighten the three bottom bolts.
11. Cut the 4″ x 12″ ribband board 39 feet long.
    The ribband board shown in Fig. 275 extends the full length of the way and it is bolted on the outboard side of the way. The ribband board acts as a guide for the sliding way.
12. Mark and cut the ends of the ribband board or plank, to fit over the end plates.
13. Clamp the ribband plank in place.
14. From the other side of the way, bore the holes through the ribband plank.
15. Place a washer under the one nut, place a metal plate under the nut next to the ribband plank.
16. Fair off the top of the way with an adz and plane.
17. Paint the top of the way.
18. Cover the way with 2¾″ surfaced oak. See Fig. 272.
    (a) Cut and fit the planks.
    (b) Clamp the planks tightly together.
    (c) Drill holes for spiking.
    (d) Counterbore holes for plugs.
    (e) Spike plank to way with ½″ sq. spikes.
    (f) Plug the holes.
19. Smooth and straighten the surface with a plane.
20. Cover the top surface with oil.
21. Paint the remainder of the way.

Building Sliding Ways

PROCEDURE

1. Lay timbers on skids.
   Two 10″ x 12″ and two 8″ x 10″ timbers are required.
2. Paint the inside surfaces.
3. Clamp timbers together.

4. Mark the holes for the bolts.
5. Bore holes with a 1-5/16″ bit.
6. Place and tighten the bolts.
7. Cut the way to the proper length. (See the leader.)
8. Place the end plates.
   (a) Locate position of plates on the end of the way.
   (b) Mark the exact location of the plate. (Even top and bottom.)
   (c) Set in the plate until flush.
   (d) Bore holes for bolts.
   (e) Place bolts and tighten.
   (f) Bore the 2″ holes for the tie plate bolts.
9. Attach the lifting pad.
   One pad is attached to each corner; each pad is bolted through the way. See Fig. 274.

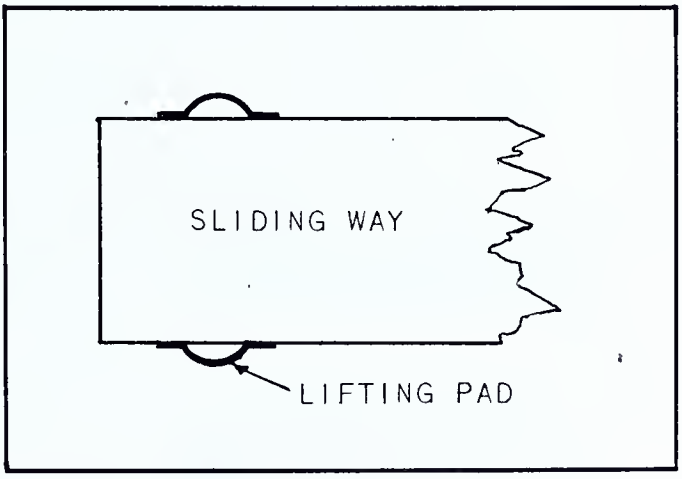


FIG. 274 — *Lifting Pads on Sliding Way*

10. Fair off the top with adz and plane.
11. Paint the top.
12. Cover the top surface with 2¾″ surfaced oak. Follow the same procedure as on ground way.
13. Fair off the oak with a plane.
14. Coat the top oak surface with oil.
15. Turn the way over with a crane.
16. Fair off the side of the way which is now up.
    The top section is made of two layers of 2¾″ x 9¾″ spruce planking. The bottom surface is grooved to receive the wedge guides. These grooves are cut into the plank in the shop. Fig. 275 shows the wedge guide.
    (a) Clamp bottom layer of stock together.
    (b) Insert the wedge guides in the grooves or dado joints.

(c) Nail planking to wedge guides.

(d) Cut to the proper length.

(e) Turn over so the wedge guides rest on the sliding way.

(f) Nail with 40-d nails a second layer of 2¾″ planks on the layer previously placed.

Notice that the second layer of plank is pushed forward 5½″. Break the longitudinal joints as shown in the end view of Fig. 272 at "A".

(g) Fasten clips to each section of the way.

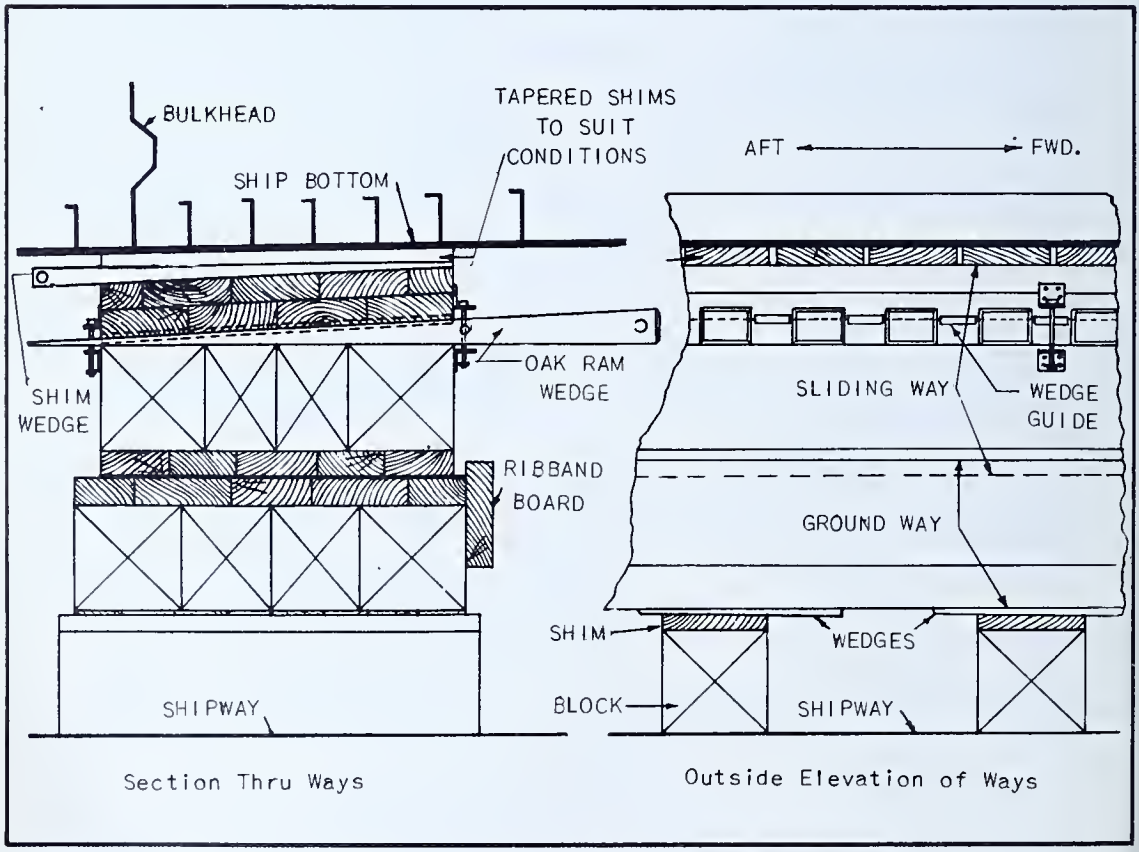


FIG. 275 — *Section of Launching Ways Showing Wedge Guide*

QUESTIONS

1. What are the two types of launching skids? How is each used?
2. From what size timbers is the ground way constructed?
3. Why is the eye bolt placed near the middle of the slab?
4. How far apart are bolts placed?
5. Explain the purpose of the end plates.
6. What procedure should be followed in laying the top oak planking?
7. Why must the end plate on the sliding way be set flush?
8. What is the purpose of the 2″ tie plate holes?
9. Explain why both surfaces of the sliding way must be "faired off"?
10. Why is the sliding way made in two sections?

JOB SHEET NO. 35
PLACING GROUND LAUNCHING WAYS

General Information

The ground way provides a solid, straight, smooth skid over which the sliding ways and the ship may slide. The launch ways or skids are run under the ship from the forward end. Shores, struts and other members must not be in the way of the skids. The ground way butts against a solid slab at the after end of the way; this solid slab is bolted securely to the launch way slab.

Aligning and bolting the ways together are not done until all the ways have been moved in under the ship.

Explanation of Terms

The term "*ways*" is used to indicate the framework of timber on which a ship is built and from which it is launched into the water.

The *stationary* way is a permanently secured way at the after end of the shipway against which the first ground way butts.

The tugger hoist is bolted to the forward end of the shipway in line with the stationary way.

The tugger hoist is used to move the trucks and the launching way which is carried on the trucks. The trucks are low, four-wheeled, and have a roller on top. See Fig. 278. The roller is

Fig. 276 — *Launching Ways Stored When Not in Use*

used to slide the launching way from one side to the other in order to get the way in the desired position.

Tools and Materials

1. Ram (Fig. 277)
2. Tugger hoist
3. 2 trucks

PROCEDURE

1. Knock out the shores which fall in the line of the ways. These are knocked out with the ram shown in Fig. 277.
2. Place two trucks on the tracks so that each truck will be about five feet from either end of the way.
3. When the trucks are in the correct position, have the crane place the launching way on the trucks.
4. Fasten a cable from the tugger hoist to the upper end plate of the launching way which is toward the forward end of the ship.

The crane can now be released; the tugger hoist will hold the trucks and launching way in position until the tugger hoist brake is released. When the brake is

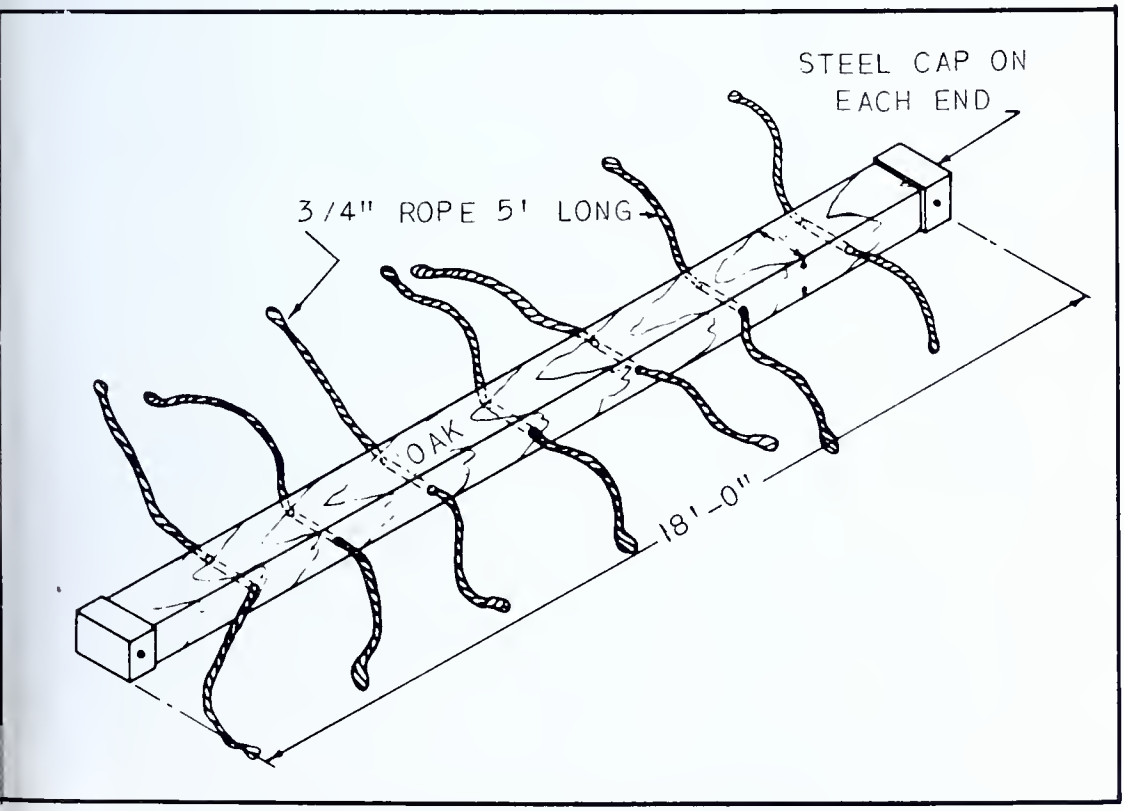


FIG. 277 — *Ram for Removing Shores*

released the trucks and way are allowed to run slowly down to their proper positions.

5. Block up the after end of the way so that the after truck can be pushed forward over half the length of the way. See Fig. 279 at "A".

6. Place a second block a little forward of the center of the way so that the after block can be released to allow clearance for both trucks to be

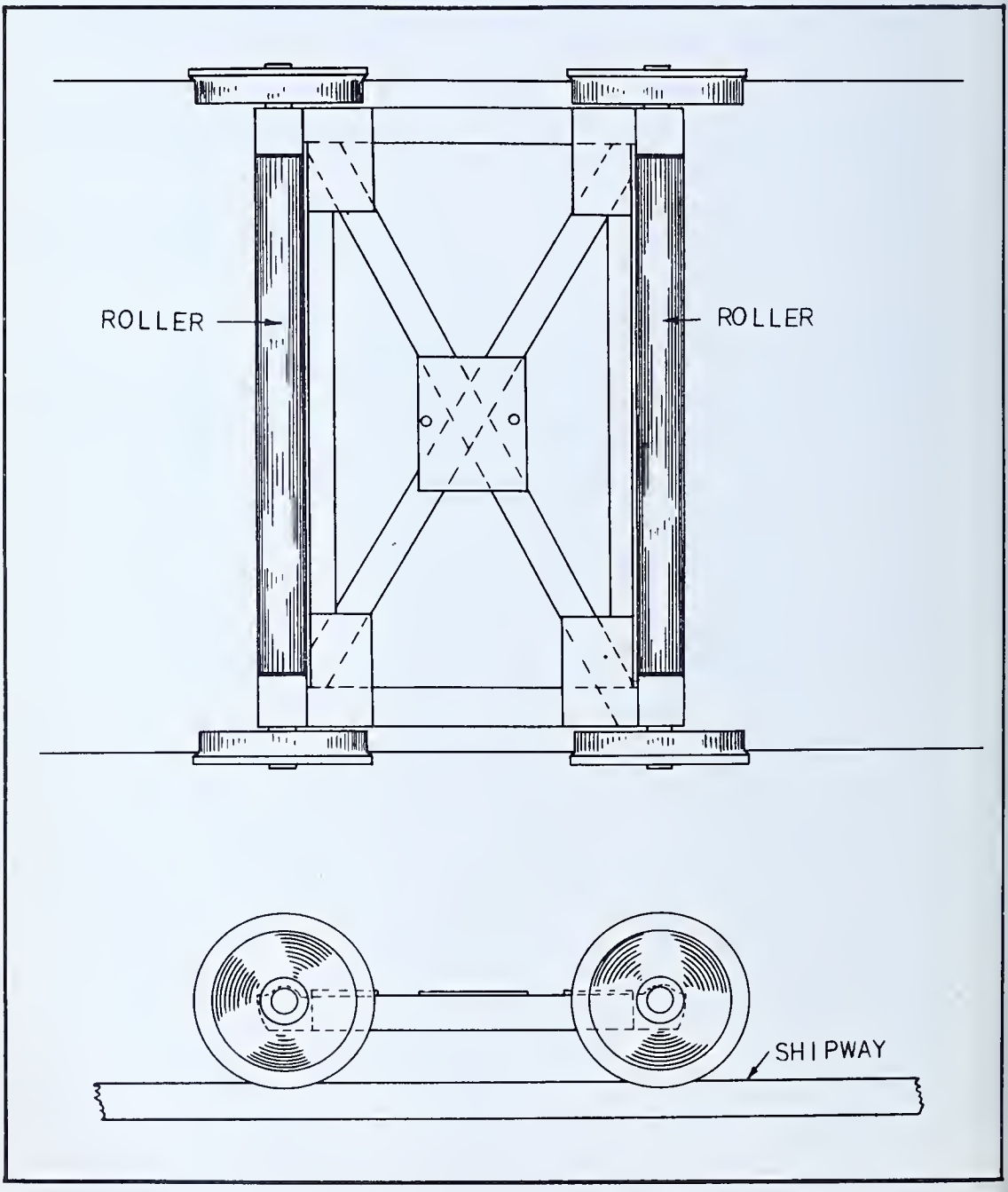


FIG. 278 — *Truck for Handling Ground Ways Under the Ship*

pulled to the forward end of the shipway to receive another launching way. See Fig. 279 at "B".

7. Block the launching ways to the proper height with approximately fourteen 12″ x 12″ blocks under each way.
8. Place shim wedges between the block and ways to make the proper adjustments in height.
9. Return the trucks to the forward end of the shipway.
10. Repeat the operations until all ground launch ways have been placed on each side of the ship.

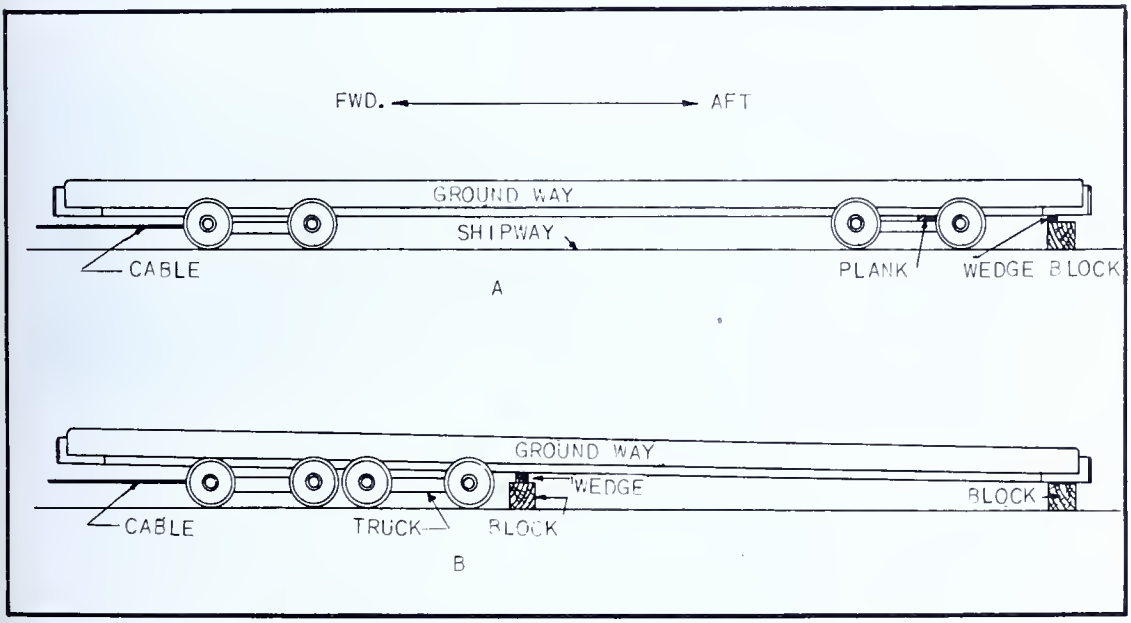


FIG. 279 — *Removing Ground Ways from the Truck*

QUESTIONS

1. **Why must certain shores be removed before ground ways can be slid into place?**
2. **How are the shores which fall in the line of the ways removed?**
3. **Explain the procedure for moving ways from the forward to the after end.**
4. **How are trucks removed from under the ground way?**
5. **How many blocks should be placed under one section of ground way?**

JOB SHEET NO. 36
SETTING, LEVELING, AND LINING LAUNCHING WAYS

General Information

In the previous job sheet the ground ways were placed into position. After all the ground ways have been placed, the sections must be bolted together, aligned for straightness, and leveled transversely. The ground ways are the skids on which the ship slides when being launched. Keep in mind that launch ways are made up of a number of sections which are bolted together to make a complete unit. The procedures which follow are for setting, leveling, and lining one section; all other sections follow the same procedure.

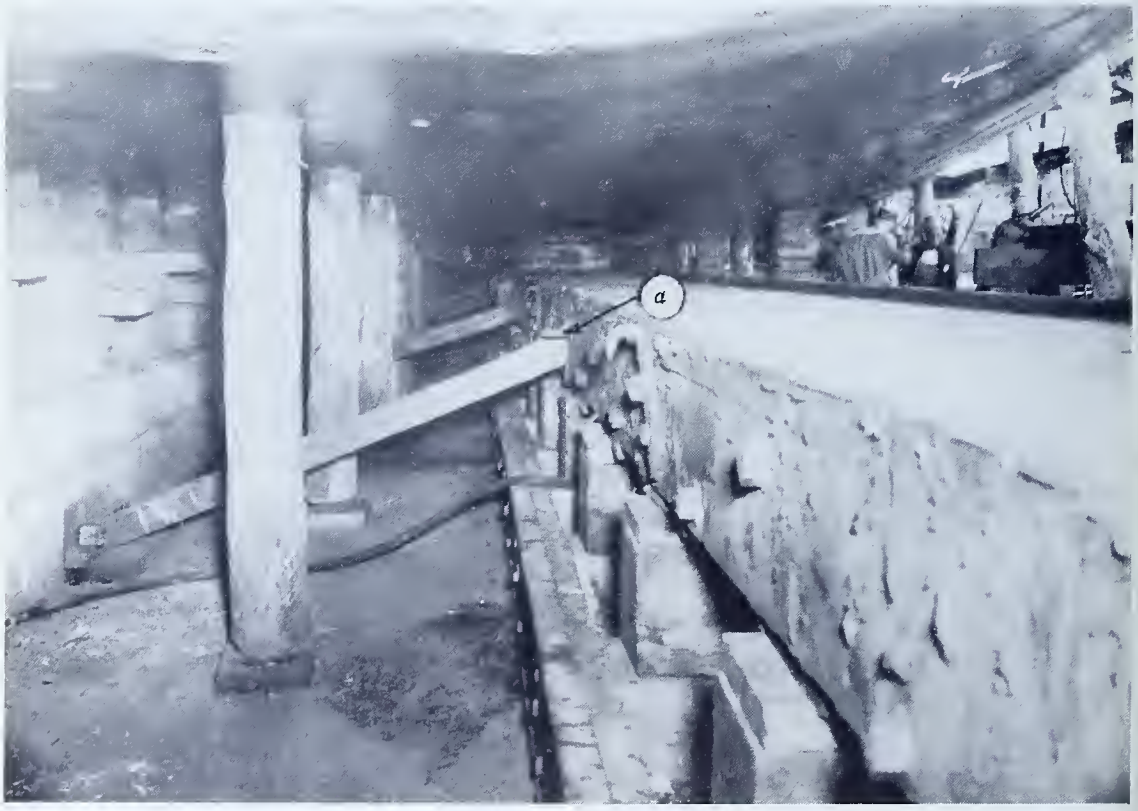


Fig. 280 — *Ground Ways Shored in Position*

Tools and Materials

1. 6′ rule
2. Plumb bob
3. Level
4. Maul
5. Wrench
6. Bolts
7. Saw
8. Jog wedges
9. Grease
10. Tugger hoist

PROCEDURE

1. Locate the center line of the ship on the under side of the keel.
2. Plumb and mark the center line on the keel block opposite the forward end of each section of the ground launch way. See "b", Fig. 282.
3. Determine the width of the way at the after end.

   The width of the ground ways at the after end is 1/3 of the width of the ship at its widest point. This measurement is a center to center measurement. See Fig. 281.
4. Straighten and level one side of the ground ways.

   Each section of ground way is laid so that the forward end is 3/16" closer to the center line of the ship than the after end. See Fig. 281. As each additional section of ground way is laid in place this 3/16" difference is maintained. The ground way sections are checked for distance by measuring from the center line of the ship as each section is laid. The entire length of the ground way is sighted for straightness, and the necessary adjustments are made before the bolts in the ends of the sections are drawn up tightly. When aligned, level the sections transversely.

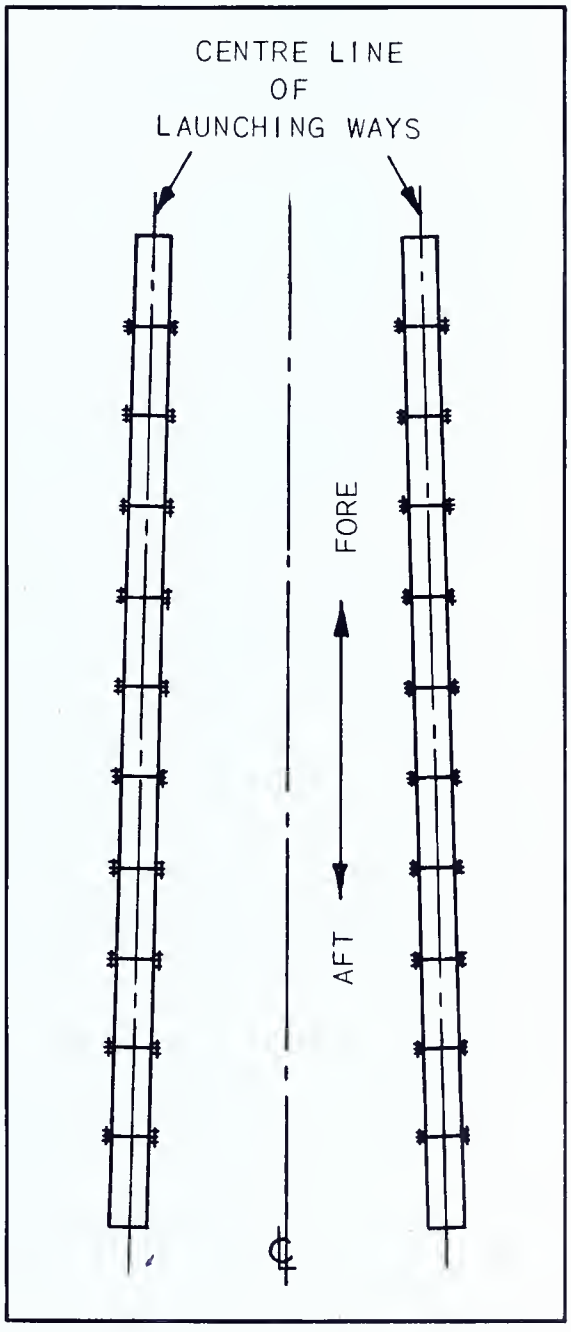


FIG. 281 — *Ground Launch Way Sections in Alignment*

5. Straighten and level the other side of ground launch way.

   The procedure for aligning this side of the way is the same as listed in step No. 4 with the exception that the forward end of each section of way must be leveled transversely from the side previously set in order that both sides of the way be the same height.

6. Shim up the ways.

7. Re-check the width of the ways.

8. Bolt the ground ways together. See Fig. 281.

9. Place the inside shores. See Fig. 282.

   Three shores are placed on each section of ground way; one shore on either end and one shore in the center. Shores run from the under side of a nut "a", Fig. 282, to the base of the gutter. Also see Fig. 280.

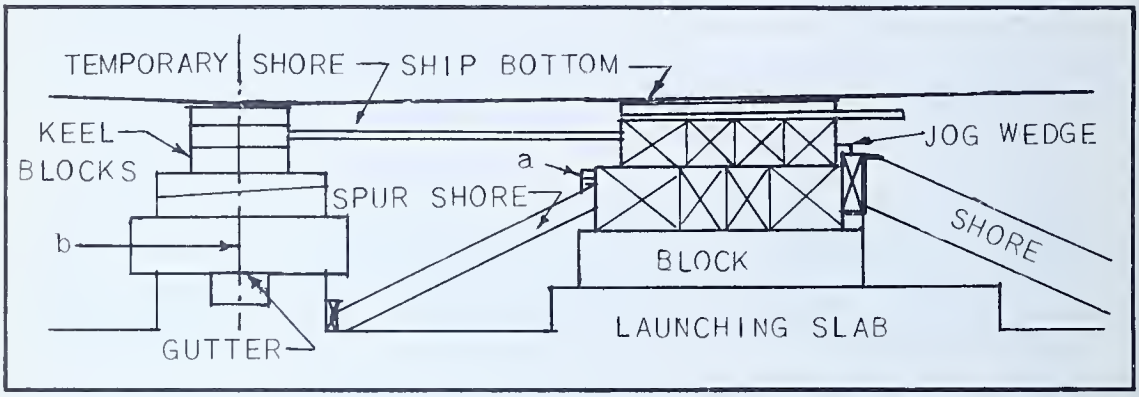


FIG. 282 — *Shoring on Ground Launch Way*

10. Clean off the top surface of the ground ways.

11. Apply grease to ways.

    Pour heated grease on the top surface of the ways which have previously been heated with a burner's flame.

12. Place the sliding launch ways, section by section.
    (a) Determine from the shape of the ship where the sliding ways will end.
    (b) Move the tugger hoist below midship.
        The purpose of the hoist is to pull the sliding ways into position.
    (c) Place the sliding way on top of the ground way.
        The sliding launch way section is hoisted on top of the ground way at the forward end of the ground launch way.
    (d) Hook tugger hoist cable to the end of the sliding way.
    (e) Pull the sliding way section to the after end of the ship.
    (f) Apply soft grease over the hard grease on the ground launch way.
    (g) Repeat operations "b", "c", "d", until all sliding way sections have been placed.

13. Place the jog wedges between the ribband board of the ground way and the sliding way. One wedge is placed at each end of each section. See Fig. 283.

14. Fasten sliding launch way sections together with tie plates.

15. Shore the sliding way tightly against the jog wedges. A shore is placed at each wedge. See Fig. 282.

16. Fasten oak timbers to ground and sliding ways. See Fig. 291, Job Sheet No. 39.

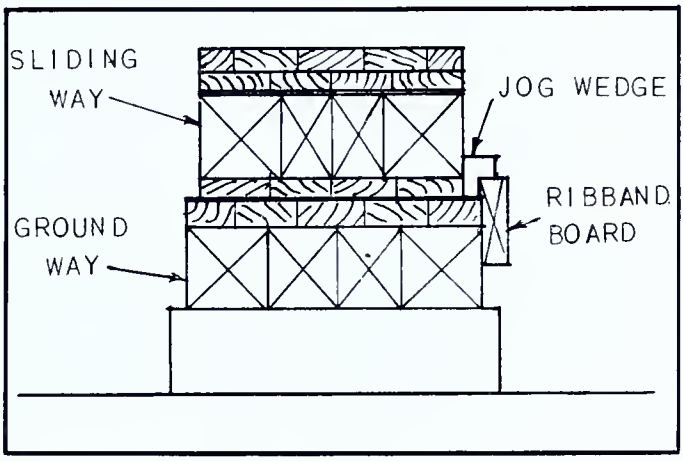


FIG. 283 — *Showing Use of Jog Wedge*

QUESTIONS

1. **How are launch ways placed in relation to the center line of the ship?**
2. **How are ground ways aligned?**
3. **What is "shimming up the ways"?**
4. **How are the ground launch ways greased?**
5. **What procedure is followed in placing sliding launch ways?**
6. **What is the purpose of jog wedges?**
7. **How many jog wedges are placed on each section of launch way?**
8. **How are ground and sliding launch ways fastened together?**

JOB SHEET NO. 37
"PACKING UP" THE SHIP

General Information

"Packing up" is the final step in the preparation of the ship for launching. The amount of packing necessary depends entirely on the style or curvature of the ship. The packing, 2″ x 8″ plank, rests on the launch ways and is built up to fit the curvature of the hull. The packing planks are fitted to the ship from a point where the curvature of the hull leaves the launch ways to near the bow of the ship. See Fig. 284.

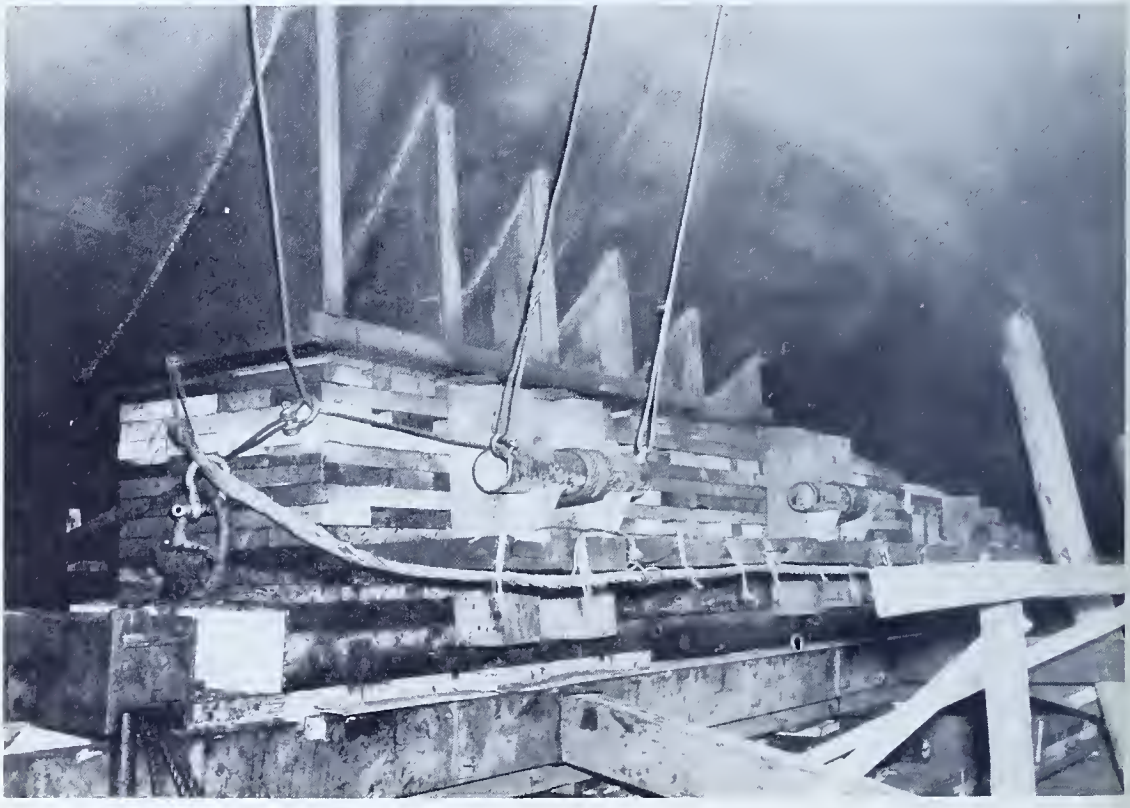


Fig. 284 — *Forward Packing Toggles and Cables*

Tools and Materials

1. Ax
2. Adz
3. Square
4. Saw
5. Maul
6. Hammer

Other Mechanics Needed: Riggers

PROCEDURE

1. Determine where the packing of the ship will begin. This depends entirely on the type of ship. (See the leader.)

DEFINITION OF TOGGLES

The toggle holes are for the purpose of pulling steel cables through the packing and around pipes which act as toggles. The purposes of this procedure are to pull the packing hard against the ship's shell to support the weight of the ship, and to stop the packing from spreading when it receives the weight.

2. Lay out the toggle holes.

   Keep the toggle high enough so that the cables pull against the bottom of the boat. The first toggle hole should not be more than four feet from the end of the packing nor less than three feet; other toggle holes should be not more than eight feet nor less than seven feet apart.

3. Build up the packing to fit the ship.

   Build up the packing from two inch plank as shown in Figs. 284 and 285. Lay

FIG. 285 — *Aft Packing, Toggles and Cables*

out each plank to fit the contour of the boat; work down with an adz and hatchet. As each plank is fitted to the boat, nail it into position.

4. Place the toggle shores, the length of which is determined by the height of the packing.

5. Spike shores to packing.

6. Have the riggers pull up the toggles.

7. Place the trip shores. See Fig. 286, Job Sheet No. 38.

8. Place the hydraulic jack. See Fig. 290, Job Sheet No. 39.
   The jack is used to start the ship sliding down the ways in case the ship should stick.

QUESTIONS

1. **What is the purpose of the launch packing?**
2. **How are the packing planks laid out and cut?**
3. **What are the purposes of toggles?**

JOB SHEET NO. 38
PLACING TRIP SHORE AND RAMMING WEDGES

General Information

The ship rests on crib work and is stabilized by shores during the time it is being erected. When the ship is ready for launching it is "packed" and the total weight is then supported by the launching ways and skids. Before the ship can be launched it is necessary to remove all of the shoring and holding members of the under structure which have been holding the ship in position on the ways. A ship weighs many thousands of tons. When it is released there is great danger of injury to workmen and even partial destruction of the ship and launching way equipment if the last holding member is not removed quickly, cleanly, and at the correct time.

Fig. 286 — *Trip Shore Assembly*

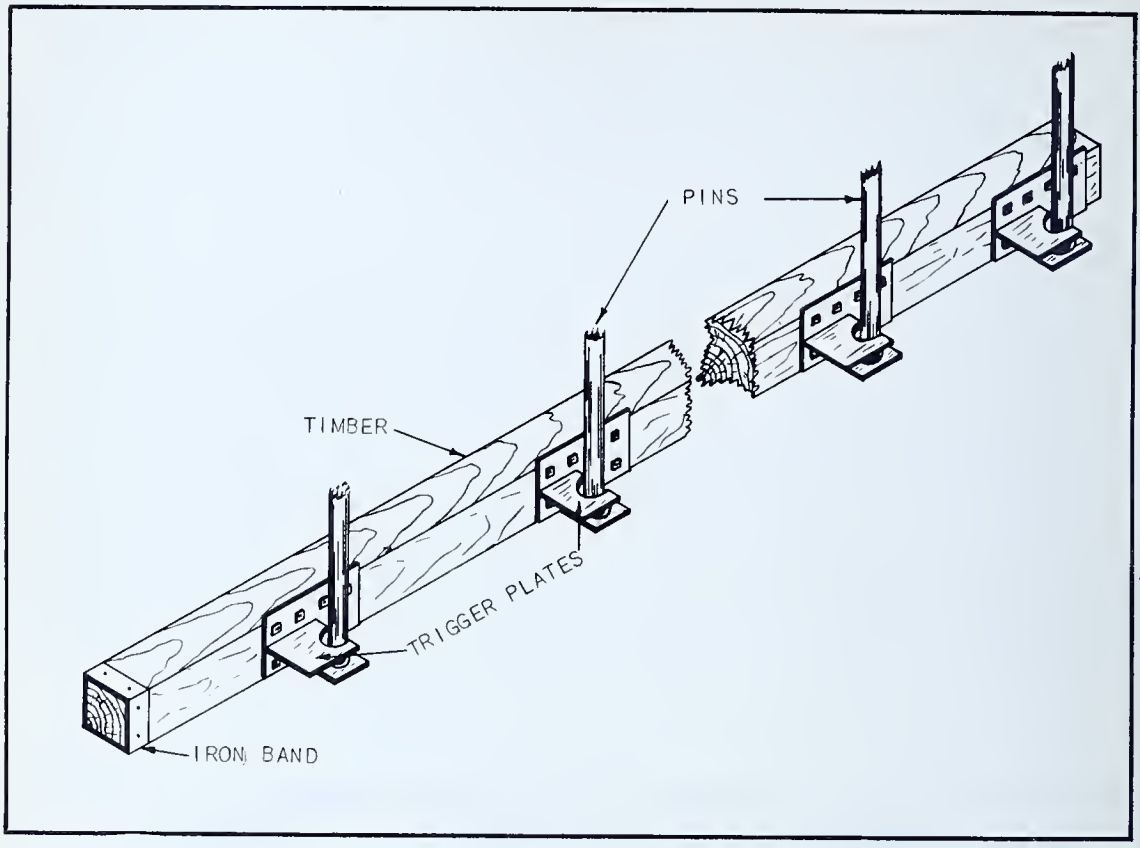


FIG. 287 — *Trip Shore Trigger*

TRIP SHORES

Trip shores are used to relieve the holding members of strain, from the time that the shores and blocks are removed until a few minutes before the ship is launched. See Fig. 286. The trip shore is made of heavy timber approximately 10″ x 12″ with iron sliding plate on the one end. It is placed amidships between the sliding ways and slopes aft to a permanent ledge built into the shipway. The trip shores are placed on both sides of both the port and starboard launching ways.

TRIP PIN

A steel trip pin is placed under the forward end of the trip shore to hold the trip shore into proper position. See Fig. 287.

TRIGGER

A large wooden trigger is run athwartships forward of the steel trip pins. This wooden trigger is approximately 8″ x 8″ x 30′ long with four steel

plates protruding on the after side of the trigger. The steel plates are put into place so that each plate touches a different steel trip pin on the same side. See Fig. 287.

The entire trip shore arrangement is left in position until after all shores, keel blocks, and bilge cribbing are removed. When the trip shores are hit a hard solid blow, the steel plates projecting from the side of the trigger automatically knock out the steel trip pins, and allow the trip shores to drop down. See Fig. 288.

Cables

The cables shown in Fig. 286 are placed by the riggers after the launching crew has finished setting everything into place. The large cable has one end fastened to the sliding ways and the other end is fastened to a permanent part of the shipway. The cables are of sufficient length to allow the ship to slide a few hundred feet into the water with the sliding ways into position under it. As the ship continues to move and the cables become taut the sliding ways are pulled from under the ship. The cables are also used for recovering the sliding ways from the water. The small cables are run through the ramming wedges to prevent their loss.

Ramming the Wedges

Prior to the launching the entire ship is wedged up to cause the weight of the ship to rest evenly, from end to end, on the launching ways. The ends of the wedges shown above the wire cable in Fig. 286 are "rammed" home tightly between the top and bottom sections of the sliding ways. The ends of the wedges are shown in Fig. 289 at "a". The purpose of ramming the wedges is to transfer as much of the weight of the ship as possible from the shores, keel blocks, and bilge blocks to the launching ways.

The launching crew prepares the ways for ramming by placing the wedges into position between the upper and lower parts of the sliding ways. A ram rail is erected at the same height as the wedges for the purpose of carrying the weight of the ram, and also to form a bearing upon which to slide the ram while hitting the wedges. See Fig. 289. The wedges are rammed at three separate times on launching day. Each ramming consists of 5 to 6 blows of the ram on the wedge. At each ramming the wedges are driven tighter, thus transferring more of the ship's weight to the launching ways.

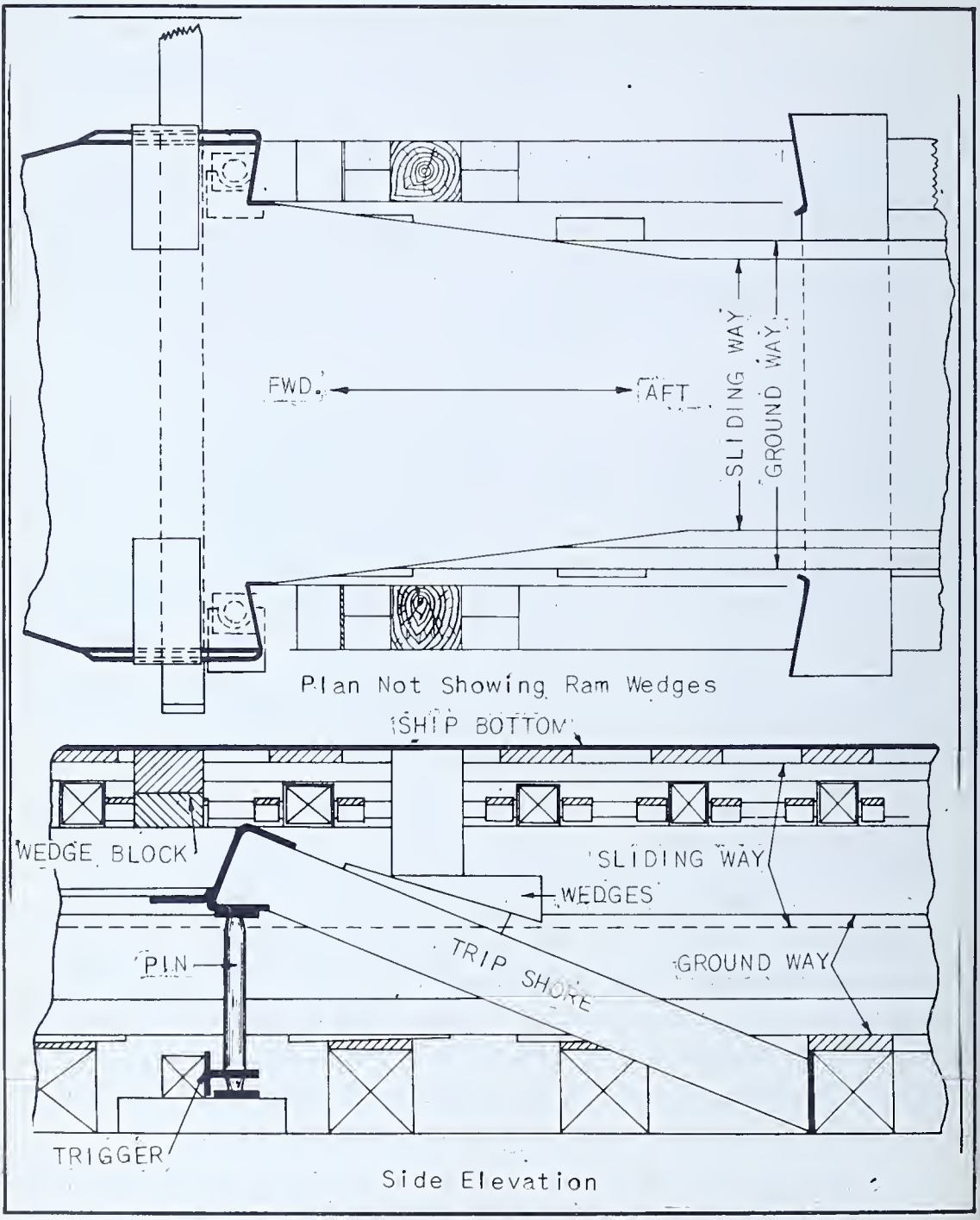


FIG. 288 — *Plan and Elevation of Ground Way and Trip Shore*

PROCEDURE

1. Place the trip shore into position.
2. Stand trip pin and plate under forward end of trip shore to hold the trip shore in position. See Fig. 286.

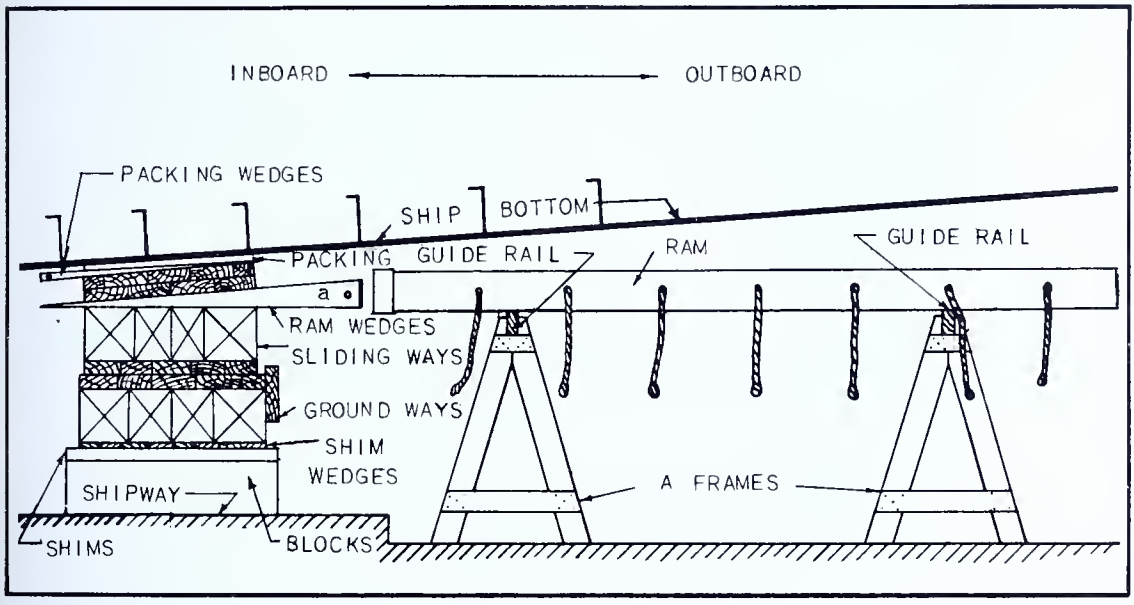


FIG. 289 — *Guide Rails for Ramming Wedges*

3. Place temporary wedges on top of the trip shore to hold the shore steady until the weight of the ship is upon the ways.
4. A large wooden trigger is next placed into position so that the steel plates on the sides strike the trip pin. See Fig. 288.
5. Cables are then fastened by the riggers to the sliding ways. See the heavy cable in Fig. 286.
6. Ram guide rails are placed level with the lower part of ram wedges as shown in Fig. 289.
7. Place ram on guide rails. See Fig. 289.
8. Proceed, as previously instructed, to ram wedges.

QUESTIONS

1. **What is the purpose of the trip shore?**
2. **Explain the trip pin.**
3. **How is the wooden trigger used?**
4. **When are the trip shores released?**
5. **Give the reasons for the steel cables shown in Fig. 286.**
6. **Why are the wedges rammed?**

JOB SHEET NO. 39
MAKING THE "CUT OFF" TO LAUNCH THE SHIP

General Information

After all preparations have been made the ship is ready for launching. In one method of launching two oak timbers must be cut through to release the ship and so allow it to slide into the water. Sawing these timbers is called the "cut-off".

The "cut-off timbers" consist of 3 pieces of oak approximately 6″ thick, 13″ wide, and 16′-0″ long. One end of each timber is bolted solidly to the sliding ways and the other end is bolted to the ground ways. There are two sets of oak timbers: one on the port side and one on the starboard side. These two timbers are the last means of holding the ship before launching.

Procedure

1. Place four men, two for each "cut-off", in position as shown in Fig. 291 at "b-b". Also see Fig. 290.

   About the center of the oak timbers at the forward end of the sliding way, a saw is used to cut off the timbers. See Fig. 291, at "a".

2. Have the men start sawing. After the sawing starts, the men pulling the saws must keep in unison so that the saw kerfs are the same depth. The timbers should be sawed through at the same time to prevent one side "breaking" before the other.

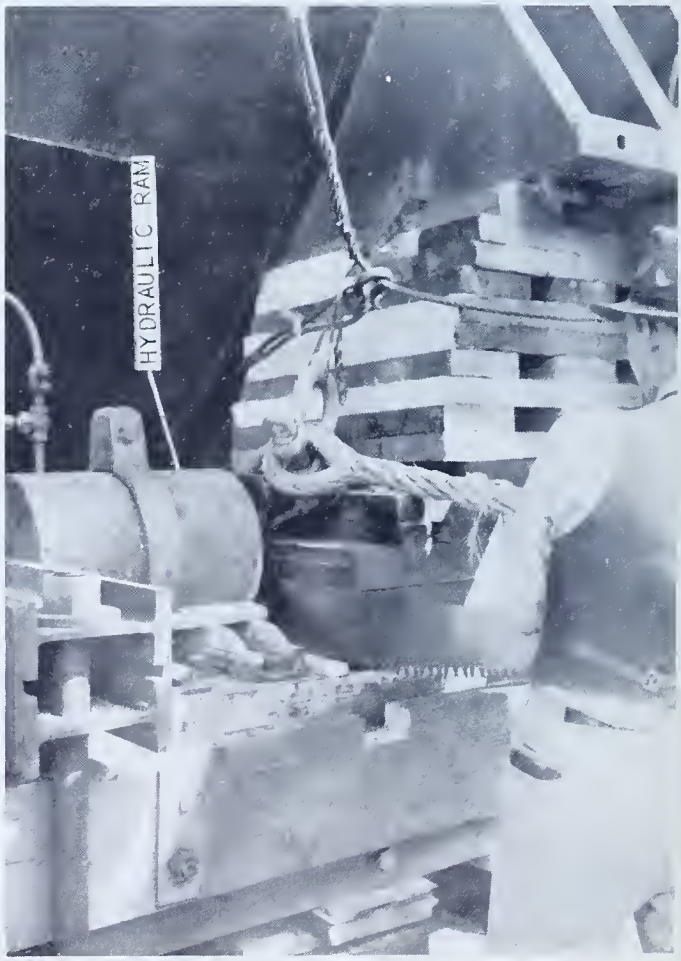


Fig. 290 — *Showing Saw in "Cut-Off" Position*

3. After the ship is launched have all shores, blocks, and wedges removed.
   These materials are gathered together in neat piles and often are placed in large iron boxes so that they can readily be moved to the next ship to be launched.

4. Remove all old launching grease.
   Laborers remove grease from the launching ways, using long-handled scrapers.

5. Have a special crew lift ashore and dismantle the sliding ways that were launched with the ship.
   The sliding ways which go with the ship are lifted ashore and dismantled.

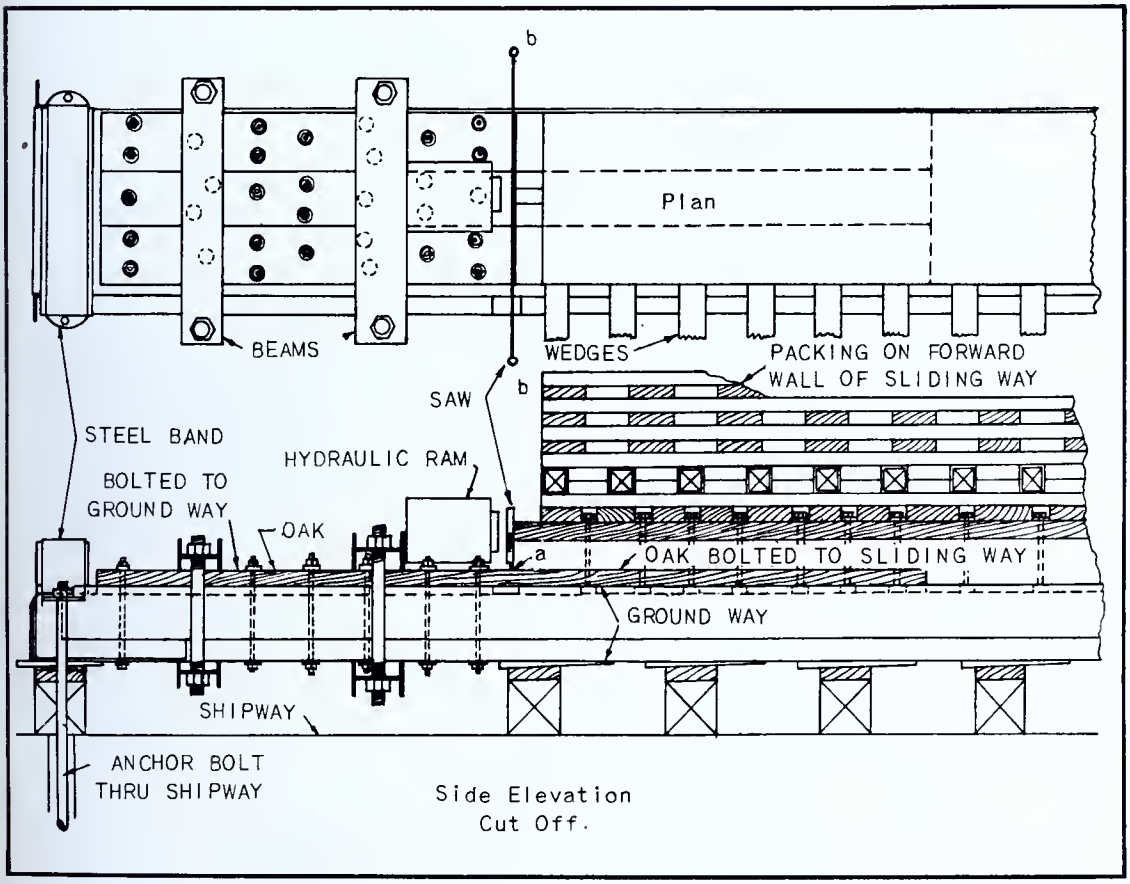


FIG. 291 — *Launching Ways (Cut-Off Location)*

QUESTIONS

1. **How are the "cut-off" oak timbers fastened?**
2. **Explain the purpose of the oak timbers.**
3. **What is the meaning of "cut-off", and at what time does it occur?**
4. **Why should the cutting of the "cut-off" timbers be done evenly?**

JOB SHEET NO. 40
CONDUCTING AN INCLINING TEST

General · Information

An inclining test is conducted by certain men delegated by the engineering department to do this job. These men are assisted by the ship carpenter who supervises the shifting of the weights from port to starboard on the ship's deck as shown in Fig. 292. The ship carpenter also assists in placing the plumb line, bucket of oil, and the trestle, all of which are shown in Fig. 293.

Stability depends largely upon the correct execution of design, and one very important check on this is the determination of the actual transverse metacentric weight of the ship by means of an inclining test which should, if possible, be made as the ship is nearing completion.

This consists in heeling the ship over to various small inclinations by means of moving heavy weights across the deck and recording the amount of weight moved, the athwartships distance through which it is moved, and the angle of heel in each case. See Fig. 292. The displacement is also carefully noted.

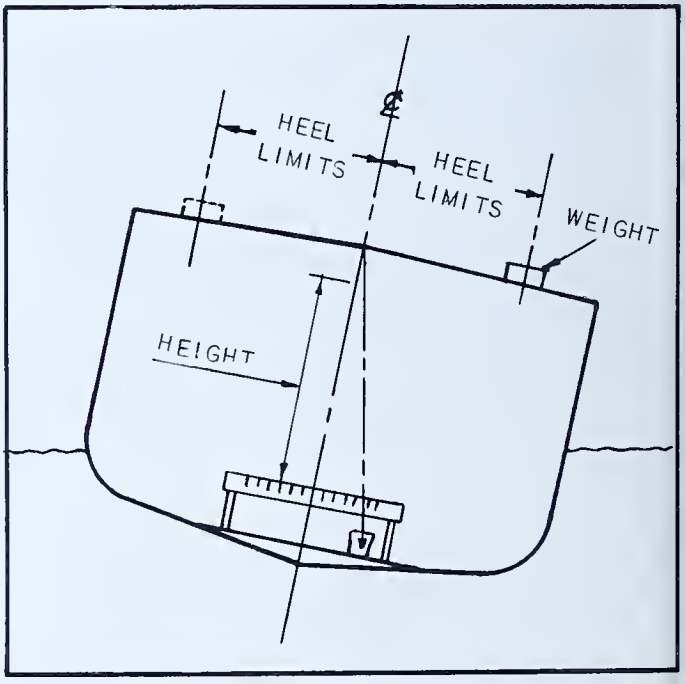


Fig. 292 — *Inclining Test*

A number of different "check" readings are taken, and if these all agree, the calculated value of the test may be assumed to be fairly accurate. During the test the ship must be entirely free from the action of any external force or forces, and there must be no free-moving weight on board which could shift and cause false estimates of the ship's stability.

The ship should be free from all material and equipment that are not permanent requirements aboard ship. Gangways are removed and all lines

are made free so that the ship can float in a free or neutral position. Plumb lines are employed in such a way that the listing of the ship may be observed and recorded.

Equipment Needed

1. 2 or 4 weights — estimated by the draftsman
2. 2 plumb bobs and lines
3. 2 target boards 1″ x 5″ x 4′-0″
4. 2 buckets of machine oil
5. 2 trestles approximately 20″ high. See Fig. 293.

Procedure

1. Hang a plumb line from a point under the deck amidship forward. See Fig. 293. The plumb line should be 12′ to 18′ in length which will be about long enough to allow the plumb bob to hang in the bucket of oil as shown.
2. Place a bucket of oil under the plumb bob so that it will register about the center of the bucket.
3. Have the crane crew hoist the weights aboard and place them fore-and-aft and port- and-starboard as shown in Fig. 292.
4. Repeat step 1 in the after end of the ship.

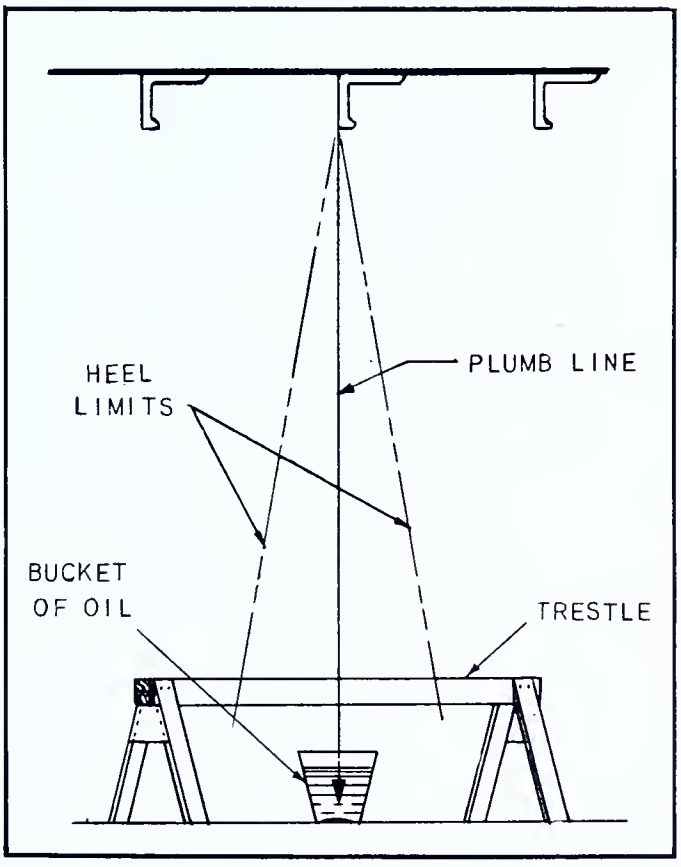


Fig. 293 — *Inclining Test Procedure*

5. Move the weights athwartship causing the ship to list. Move the bucket of oil to keep the plumb bob about the center.
6. Place a trestle so that the plumb line will just touch the side of it. On the

trestle is a scale. See Fig. 292. The scale is there for the purpose of taking a reading to check the swing of the plumb line.

7. Repeat step 5 but move the weights in the opposite direction.

8. Repeat the entire procedure of shifting the weights athwartship and taking readings on the scale.

This repetition gives a double check. From the readings, the draftsman can make the proper calculations and report on the stability of the ship.

QUESTIONS

1. **What is an inclining test?**
2. **Explain how and where plumb bob is hung?**
3. **Why is the bucket of oil used?**
4. **Explain the use of weights.**
5. **Why are the tests repeated?**

Appendix I

GLOSSARY

SHIPBUILDING TERMS AND DEFINITIONS

A

ADZ — A hewing tool having its cutting blade at right angles to the handle. The type used in the shipyard has a lip on each side and is called a foot adz or a lip adz.

AFTER-PEAK TANK — A tank in the extreme aft end or stern of a ship.

AFTER SIDE — Toward, at, or near the stern.

AMIDSHIPS — At or near the midship section of the ship.

ANCHOR — A heavy hook-shaped device for holding a ship at rest in water. The anchor grips the ocean bottom and is fastened to the ship by a chain.

ANGLE CLIP — A short piece of angle bar.

ASSEMBLE — To fit together small parts in making a large section or part.

ATHWARTSHIP — Across the ship at right angles to the center line.

AUGER — A carpenter's tool for boring holes in large timbers.

B

BATTEN — A long, narrow strip of wood for fairing lines. A wooden, protective strip in cargo holds.

BEAM — An athwartship member supporting a portion of a deck. Also, the width of the ship.

BETWEEN DECKS — The distance from the surface of one deck to the surface of the next.

BILGE — The rounded portion of a ship's shell which connects the bottom with the sides. The recess into which the drain water (or bilge water) of a ship runs.

BILGE BLOCKS — Supporting blocks used under bilge for support during construction or dry-docking.

BILGE WATER — The accumulation of water due to leaks, sweat, etc. It is so named because it collects in the bilge of the ship.

BOAT DECK — A deck on which lifeboats are kept.

BOAT FALLS — Tackle used to raise and lower a lifeboat on the davits.

BODY PLAN — A drawing which shows frame lines in elevation.

BOOM — A heavy arm (usually wood) pivoted at one end, used for loading and unloading cargo.

BOOM REST — A bracket or holder in which the boom is placed when not in use.

BOOM STEP — A socket for the end of the boom.

BOW TOWERS — Two towers placed side by side at the forward end of the way. Spawls, which support the planking, run through and between the towers.

BRACKET — A triangular plate used to connect rigidly two or more parts, such as a deck beam to a frame, a frame to a margin plate, etc.

BULKHEAD — A vertical partition corresponding to the wall of a room, extending either athwartship or fore and aft. A steel partition in a ship.

BULWARK — The side of a ship above the weather deck.

BUOYANCY — Ability to float; lifting power when immersed.

C

CALKING — A process for making decking or planking watertight by driving cotton and oakum into the seams with a calking iron and mallet.

CAMBER — The athwartship rise or crown of a deck.

CAP LOGS — 12″ x 12″ horizontal, transverse logs placed on piling to make up the shipway.

CARGO — Freight carried by a ship.

CARGO BATTENS — Strips of wood used to prevent the cargo's coming in contact with the hull of the ship.

CARGO HATCH — A large opening in the deck which permits the loading of the dry cargo.

CARGO HOLD — The dry cargo space of the ship.

CENTER LINE — The middle line of the ship, extending from stem to stern.

CHAIN LOCKER — A compartment in the forward portion of a ship in which anchor chain is stowed.

CHALK LINE — A strong, thin, cotton cord. The line is passed over a ball of colored chalk, after which it is stretched firmly through the established points of the line. While held in this position, the middle of the line is snapped.

CHAMFER — To cut off the sharp edge of a corner. To bevel.

CHOCK — A cradle or support for a lifeboat.

CLIP — A short piece of angle iron which is bolted or welded in position to act as a stop or a support.

CLAMP — A metal or wood fastening that holds material together.

COFFERDAM — A narrow vacant space between two bulkheads. A double watertight bulkhead.

COLLAR — A flanged band or ring.

COUNTERSINK — To counterbore or taper a hole to allow a rivet or bolthead to be flush or below the surface.

CRADLE — A form on which bows, etc., are assembled. The support in which a ship rests during launching; a launching cradle.

CRANES — Heavy hoisting apparatus on the sides of a ship to handle boats, rafts, etc.

CROSS PLANKS — 3″ x 10″ timbers running from the longitudinal stiffeners of the side shell to the longitudinal stiffeners of the longitudinal bulkhead.

CROWN OF DECK — The camber of a deck, the shape in which a deck is built so that it will shed water.

D

DAVITS — A set of cranes or radial arms on the gunwale of a ship, from which are suspended the lifeboats.

DEAD FLAT — A portion of the side or bottom of a ship where the plating has no curvature; also, the midship portion of constant cross section. (The parallel middle body.)

DEAD RISE — The rise or upward slant of the bottom of a ship from the keel to the bilge.

DEADWEIGHT — The total weight of cargo, fuel, water, stores, passengers and crew, and their effects, which a ship can carry.

DECK — A deck in a ship corresponds to a floor in a building.

DECKHOUSE — A house erected on the deck of the ship for any purpose.

DECLIVITY — The inclination of shipways to provide for launching the ship.

DECLIVITY BOARD — An accurately planed board whose two opposite edges are not parallel, but form an angle equal to that of the slope of the shipway.

DIVIDERS — A tool that is used to scribe circles or to divide a given length into equal parts.

DOUBLE BOTTOM — Compartments at the bottom of the ship between the inner and outer bottoms, used for ballast tanks, water, fuel oil, etc.

DOUBLING PLATE — A plate fitted outside or inside another to give extra strength or stiffness.

DRAFT MARKS — Numbers on the fore, aft, and midship sections of the hull which represent the vertical distance (in feet) of the ship below the surface of the water.

DROP BOLT — A bolt dropped through a hole in the end of planking to prevent spawls from sliding.

E

EIGHT-SQUARE — Method or table used when rounding up spars or booms.

F

FAIRING — Correcting or fairing up the lines or structural members of a ship; assembling the parts of a ship so that they will be fair; that is, without kinks, bumps, or waves; bringing the rivet holes into alignment.

FLUSH — Even with or level.

FORECASTLE — That part of the upper deck forward of the foremast. It is sometimes used as the crew's quarters.

FOREPEAK — The narrow extremity of a ship's bow. Also the hold space within it.

FRAMES — Ribs forming the skeleton of a ship.

FRAME SPACING — The fore-and-aft distance between adjacent frames.

FRAME, WEB — A heavy side or continuous frame, made with web plate for extra stiffness.

FREEBOARD — The vertical distance from the upper watertight deck to the water line when the ship is fully loaded.

FURRING — Pieces of wood attached to a surface. A framing or foundation for interior panel work or ceiling.

G

GIRDER — Fore-and-aft stiffening member for deck or bottom shell.

GRATING — A perforated platform. Slats or strips fastened on pieces running at right angles to them.

GROMMET — A ring of lamp wicking used as a washer or gasket around bolts and studs to make watertight joints.

GROUND WAYS — Timbers secured to the ground under the hull on each side of the keel. The ship is launched from the ground ways.

GAUGE BLOCK — A block of wood 1" square and approximately 12" long. It is used as a gauge block in the setting of the keel blocks so that each block can be adjusted separately.

GUDGEONS — Bosses on the stern post drilled for pins (pintles) on which the rudder swings.

GUTTER — The gutter is the center of the shipway. It is used to draw the test water from the tanks. The walls of the gutter also serve to support the keel blocks.

H

HALF-BREADTH MEASUREMENT — A measurement from the center line of the ship to the outer shell at a certain specified water line.

HANDRAIL — A handrail is a rail placed at a convenient height for use as a guide, support, or safeguard alongside a ladder or platform.

HATCH — An opening in the deck of a ship for loading or unloading cargo.

HOLD — The inside of a hull; cargo space.

HULL — The shell of a vessel.

I

INBOARD — Inside the ship; toward or nearer the center line.

INNER BOTTOM — Plating forming the upper surface of the double bottom. Also called tank top.

INNER SHELL — A plated surface or "shell" inside the outer shell plating, used as additional protection in case of collision or other accidents. The space between the inner and outer shells is often used as a storage space for liquid ballast or cargo.

J

JOGGLE — An abrupt bend or offset in a plate, bar, or frame to eliminate the use of liners.

K

KEEL — The principal fore-and-aft member of a ship's frame. The keel runs along the bottom, connecting the stem and stern, and to it are attached the frames of the ship.

KEEL BLOCKS — Heavy blocks which support the keel of the ship during construction.

KEEL, FLAT — The bottom-shell strake on the center line of the ship.

KEEL, VERTICAL — Vertical plate used as reinforcement for keel, often called center keelson.

KERF — A slit or notch made in a piece of wood by cutting or sawing.

KING POST — A stub mast, outward from center line, used to carry cargo booms; king posts often serve as ventilators.

L

LAUNCHING — The operation of placing a hull in the water by allowing it to slide down on greased skids called launching ways.

LAUNCHING WAYS — Ways placed under a ship after the hull construction is complete and ready to be placed in the water. The launching ways are a means of skidding the ship into the water.

LAY OUT — To measure or scribe from a template before cutting.

LEG — A vertical wooden support from one spawl to another where the length of the spawl extending beyond the tower is more than five feet.

LENGTH OVER ALL — The length of a ship measured from the extreme forward end to the aftermost point of the stern.

LINES — The form of a ship as represented by its moulded surface.

LOAD WATER LINE — The line of the surface of the water on a ship when loaded to the designed draft.

LONGITUDINAL BULKHEAD — A wall or partition extending lengthwise on the ship.

M

MAIN DECK — Usually the deck immediately below the shelter or weather deck.

MARGIN BOARD — A plank around the edge of the deck.

MAST — A spar or hollow steel pipe tapering toward the top, placed on the center line of the ship.

MAST WEDGES — Wooden wedges used around masts and top masts to secure and steady them in place and to make the hole or space they are dropped into watertight.

MAUL — A heavy hammer or iron mallet.

MIDSHIP — At or near the middle point of the length of a ship.

MIDSHIP SECTION — A vertical cross section through the ship, midway between the forward and after perpendiculars.

MOLD LOFT — A shed or building with large, smooth floor surfaces on which the lines of a ship are laid out in full scale.

N

NAVIGATION BRIDGE — The platform or deck used for taking observations and directing the handling of the ship.

NIBBING STRAKE — A deck plank laid next to the margin board to receive the nibbed ends of the decking.

O

OAKUM — A material made out of tarred rope fibers. It is used for calking seams in a wooden deck.

OILTIGHT — Sealed by welding or calking to prevent oil leakage. (Closer rivet spacing is required than for watertight work.)

OUTBOARD — Away from the center line of a ship; toward the side of a ship.

P

PAYED — Coated with hot pitch. Payed is a term used by a calker when he pitches the deck with a pitch ladle. ("He payed the deck with pitch.")

PLANK — A piece of lumber from 1½" to 3" thick and of various widths.

PLANKING — Wood covering for decks, etc.

PLUGGING, DECK PLUGGING — A means of finishing a countersunk hole by placing in it a soft wood plug that is matched with the grain and then smoothed off to a good finish.

POOP DECK — The first deck above the shelter deck at the after end of a vessel.

PORT SIDE — The left-hand side of a ship as the observer looks toward the bow.

PREFABRICATED — Assembled in the shop.

PROPELLER — A rotating device which drives a ship through the water.

R

RATCHET TURNBUCKLE — A screw device which is placed between cables to draw them tight.

RUDDER — A flat structure of wood or metal attached upright to the sternpost (or in single-screw vessels, to the rudderpost) of a vessel by hinges, or pintles and gudgeons, so that it can be turned, as by a tiller, causing the head of the vessel to turn in the same direction because of the resistance offered to the water by the rudder.

RUDDERPOST — After post of stern frame to which the rudder is hung. (Also called sternpost.)

S

SCARF — To taper or bevel the edge or side of a piece of material to make a lap joint.

SCREEN BULKHEAD — A bulkhead usually placed between the engine room and the boiler room. This bulkhead is fireproof, dustproof, and gastight.

SCRIBE — To draw a line with a pointed instrument.

SHEAR LINE — A line at which a shearing cut is to be made.

SHELL OF A SHIP — The skin or plates of the hull.

SHOLE BLOCK — A wooden 3" x 10" x 16" block placed under a shore to support it and to aid in driving the wedges when securing the shore.

SHORE — A beam set endwise as a prop.

SIDE SHELL SECTION — A prefabricated side wall of one tank. It has longitudinal stiffeners and side frames attached.

SIGHT EDGES — Visible edges of plating (outside shell and above decks).

SLEEPERS — Foundation timbers for flooring or tank top, etc.

SLIDING WAYS — A structure of heavy timbers placed between ground ways and cradle to support the ship during launching.

STAGING — Planks or scaffolding from which shipbuilders work on the sides or under the decks of a ship.

STAGING BRACKETS — Pieces of flat metal ⅜" x 4" x 40" long with 15/16" holes punched every 4" apart so that from center of first hole to center of last hole measures 36".

STAGING STRUT — A sloping support running athwartship to carry the outside staging at the forward and after ends of a ship.

STAGING TOWER — The main support for the outside staging of the ship. It is made of either wood or metal.

STANCHION — A pillar or iron post for supporting decks, etc.

STARBOARD — The right-hand side, as the observer looks from aft forward.

SPUR — A short, diagonal brace which is cut from a piece of 3" x 5" timber.

STEM — The bow of the ship, the part where the port and starboard meet up forward.

STERN — The after or rear end of the ship.

STIFFENER — An angle bar, T-bar, channel, etc., used to stiffen plating of a bulkhead or other member.

STRAIGHTEDGE — A board with surfaced sides and edges and with its two edges straight and parallel.

STRAKE — A fore-and-aft course or row, of shell or other plating.

STRINGER — A fore-and-aft member used to give longitudinal strength. Depending on location, these are called hold stringers, bilge stringers, side stringers, etc.

STRUT — A support for a propeller tail shaft (used on ships with more than one propeller).

SURFACED PLANK — A heavy piece of timber having the two face sides smooth.

T

TACK — A small, short, sharp-pointed nail, usually having a broad, flat head.

TANKER — A ship that is equipped with tanks for carrying a liquid cargo.

TANK TOP — A wood covering placed on the metal tank top in the cargo hold of a ship to protect the tank and the cargo.

TARGET BLOCKS — A piece of planking, 10″ wide, which is placed tight between the walls of the gutter and flush with the top. On this block, eventually, there is established a center line marking of the ship. When checking the center line of the ship, always check back to the mark found on this block.

TEMPLATE — A pattern.

TIE ROD — Long rods used for holding down or holding together any structure.

TRANSVERSE — Athwartship; at right angles to the keel in a horizontal plane.

TRANSVERSE BULKHEAD — A vertical partition running at right angles to the keel.

TRANSVERSE FRAMES — Athwartship members forming the "ribs" of the ship.

U

UPRIGHT — A vertical plank having hangers bolted at certain intervals to support staging planks.

V

VERTICAL STIFFENER — A T-bar running vertically to strengthen the bulkhead.

VERTICAL TARGET — A straight, oblong piece of white pine lumber, 1″ x 3″ x 6′ - 0″. This target is nailed to the base of the keel block and is used in establishing the center line of the ship. These boards are made in the shop.

W

WATER LINE — Any one of certain lines of a ship parallel with (and at various heights above) the base line. In half-breadth plans the water lines are smooth curves showing the shape of the ship; in profile plans they are projected as straight lines.

WATERTIGHT — So riveted, calked, or welded as to prevent the passage of water.

WATERWAY — The gutter which provides for drainage along the edge of a deck.

WAYS — The framework of timber, concrete and steel on which a vessel is built and from which it is launched into the water.

WEB — A thin, stiffening member of some steel shapes, such as the connecting plate between the two legs of a channel or the connecting web of an I-beam.

WEB FRAME — A frame with a deep web; a rib forming the skeleton of the ship. The frame is larger than an ordinary frame and provides additional rigidity and strength.

WINDLASS — A machine used to hoist the anchors by winding in the anchor chain.

WING BULKHEAD — A continuation of the center transverse bulkhead. The wing bulkhead runs from the center transverse bulkhead.

Appendix II

TABLE I

DECIMAL EQUIVALENTS OF FRACTIONS OF ONE INCH

1/64 ..... .015625	11/32 ..... .34375	43/64 ..... .671875
1/32 ..... .03125	23/64 ..... .359375	11/16 ..... .6875
3/64 ..... .046875	3/8 ..... .3750	45/64 ..... .703125
1/16 ..... .0625	25/64 ..... .390625	23/32 ..... .71875
5/64 ..... .078125	13/32 ..... .40625	47/64 ..... .734375
3/32 ..... .09375	27/64 ..... .421875	3/4 ..... .7500
7/64 ..... .109375	7/16 ..... .4375	49/64 ..... .765625
1 8 ..... .1250	29/64 ..... .453125	25/32 ..... .78125
9/64 ..... .140625	15/32 ..... .46875	51/64 ..... .796875
5/32 ..... .15625	31/64 ..... .484375	13/16 ..... .8125
11/64 ..... .171875	1/2 ..... .5000	53/64 ..... .828125
3/16 ..... .1875	33/64 ..... .515625	27/32 ..... .84375
13/64 ..... .203125	17/32 ..... .53125	55/64 ..... .859375
7/32 ..... .21875	35/64 ..... .546875	7/8 ..... .8750
15/64 ..... .234375	9/16 ..... .5625	57/64 ..... .890625
1/4 ..... .2500	37/64 ..... .578125	29/32 ..... .90625
17/64 ..... .265625	19/32 ..... .59375	59/64 ..... .921875
9/32 ..... .28125	39/64 ..... .609375	15/16 ..... .9375
19/64 ..... .296875	5/8 ..... .6250	61/64 ..... .953125
5/16 ..... .3125	41/64 ..... .640625	31/32 ..... .96875
21/64 ..... .328125	21/32 ..... .65625	63/64 ..... .984375
	1 ..... 1.0000	

TABLE II

DECIMALS OF A FOOT IN INCHES

Inch	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"
0	.0	.0833	.1677	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167
1/16	.0052	.0885	.1719	.2552	.3385	.4219	.5052	.5885	.6719	.7552	.8385	.9219
1/8	.0104	.0937	.1771	.2604	.3437	.4271	.5194	.5937	.6771	.7604	.8437	.9271
3/16	.0156	.0990	.1823	.2656	.3490	.4323	.5156	.5990	.6823	.7656	.8490	.9323
1/4	.0208	.1042	.1875	.2708	.3542	.4375	.5208	.6042	.6875	.7708	.8542	.9375
5/16	.0260	.1094	.1927	.2760	.3594	.4427	.5260	.6094	.6927	.7760	.8594	.9427
3/8	.0312	.1146	.1979	.2812	.3646	.4479	.5312	.6146	.6979	.7812	.8646	.9479
7/16	.0365	.1198	.2031	.2865	.3698	.4531	.5365	.6198	.7031	.7865	.8698	.9531
1/2	.0417	.1250	.2083	.2917	.3750	.4583	.5417	.6250	.7083	.7917	.8750	.9583
9/16	.0469	.1302	.2135	.2969	.3802	.4635	.5469	.6302	.7135	.7969	.8802	.9636
5/8	.0521	.1354	.2188	.3021	.3854	.4688	.5521	.6354	.7188	.8021	.8854	.9688
11/16	.0573	.1406	.2240	.3073	.3906	.4740	.5573	.6406	.7240	.8073	.8906	.9740
3/4	.0625	.1458	.2292	.3125	.3958	.4792	.5625	.6458	.7292	.8125	.8958	.9792
13/16	.0677	.1510	.2344	.3177	.4010	.4844	.5677	.6510	.7344	.8177	.9010	.9844
7/8	.0729	.1562	.2396	.3229	.4062	.4896	.5729	.6562	.7396	.8229	.9062	.9896
15/16	.0781	.1615	.2448	.3281	.4115	.4948	.5781	.6615	.7448	.8281	.9115	.9968

All decimal dimensions are given in feet in the above table. For example: A length of 8½" is read .7083 feet which means that 8½" is a little more than seven-tenths of one foot.

TABLE III

WIRE TACKS

Size Ozs.	Length Ins.	No. per Lb.	Size Ozs.	Length Ins.	No. per Lb.	Size Ozs.	Length Ins.	No. per Lb.
1	1/8	16,000	4	7/16	4,000	14	13/16	1,143
1 1/2	3/16	10,666	6	9/16	2,666	16	7/8	1,000
2	1/4	8,000	8	5/8	2,000	18	15/16	888
2 1/2	5/16	6,400	10	11/16	1,600	20	1	800
3	3/8	5,333	12	3/4	1,333	22	1 1/16	727
...	..	....	..	..	....	24	1 1/8	666

TABLE IV

FINISHING NAILS

Size	Length in Ins.	Gauge
3d	1 1/4	15 1/2
4d	1 1/2	15
5d	1 3/4	15
6d	2	13
7d	2 1/4	13
8d	2 1/2	12 1/2
10d	3	11 1/2

TABLE V

ORDINARY SPIKES

Size	Length in Ins.	Gauge No.	Approximate No. per lb.
10d	3	6	41
12d	3 1/4	6	38
16d	3 1/2	5	30
20d	4	4	23
30d	4 1/2	3	17
40d	5	2	13
50d	5 1/2	1	10
60d	6	1	9
7 Inch	7 Inches	5/16"	7
8 "	8 "	3/8	4
9 "	9 "	3/8	3 1/2
10 "	10 "	3/8	3
12 "	12 "	3/8	2 1/2

TABLE VI

COMMON NAILS

Size	Length Ins.	Gauge No.	Approximate No. to Lb.
2d	1	15	876
3d	1 1/4	14	568
4d	1 1/2	12 1/2	316
5d	1 3/4	12 1/2	271
6d	2	11 1/2	181
7d	2 1/4	11 1/2	161
8d	2 1/2	10 1/4	106
9d	2 3/4	10 1/4	96
10d	3	9	69
12d	3 1/4	9	63
16d	3 1/2	8	49
20d	4	6	31
30d	4 1/2	5	24
40d	5	4	18
50d	5 1/2	3	14
60d	6	2	11

TABLE VII

METRIC MEASURE OF LENGTH IN U.S. STANDARDS		
	INCHES	FEET
Millimeter	.039370	.003281
Centimeter	.393704	.032809
Decimeter	3.93704	.328087
Meter	39.3704	3.28087

TABLE VIII

WOOD SCREW DIAMETERS

No.	Decimal	Inch	Actual Diameter	No.	Decimal	Inch	Actual Diameter
0	.0578	1/16		15	.2552	1/4	
1	.0710	5/64		16	.2684	17/64	
2	.0842			17	.2816	9/32	
3	.0973	3/32					
4	.1105	7/64		18	.2947	19/64	
5	.1236	1/8		20	.3210	21/64	
6	.1368	9/64					
7	.1500			22	.3474	11/32	
8	.1631	5/32		24	.3737	3/8	
9	.1763	11/64					
10	.1894	3/16		26	.4000	13/32	
11	.2026	13/64		28	.4263	7/16	
12	.2158						
13	.2289	7/32		30	.4520	29/64	
14	.2421	15/64					

The column headed *No.* gives the number of the screw. The column headed *decimal* gives the diameter as a decimal fraction. The column headed *inches* gives the diameter in fractions of an inch. The column headed *actual diameter* gives the approximate diameter of the screw body.

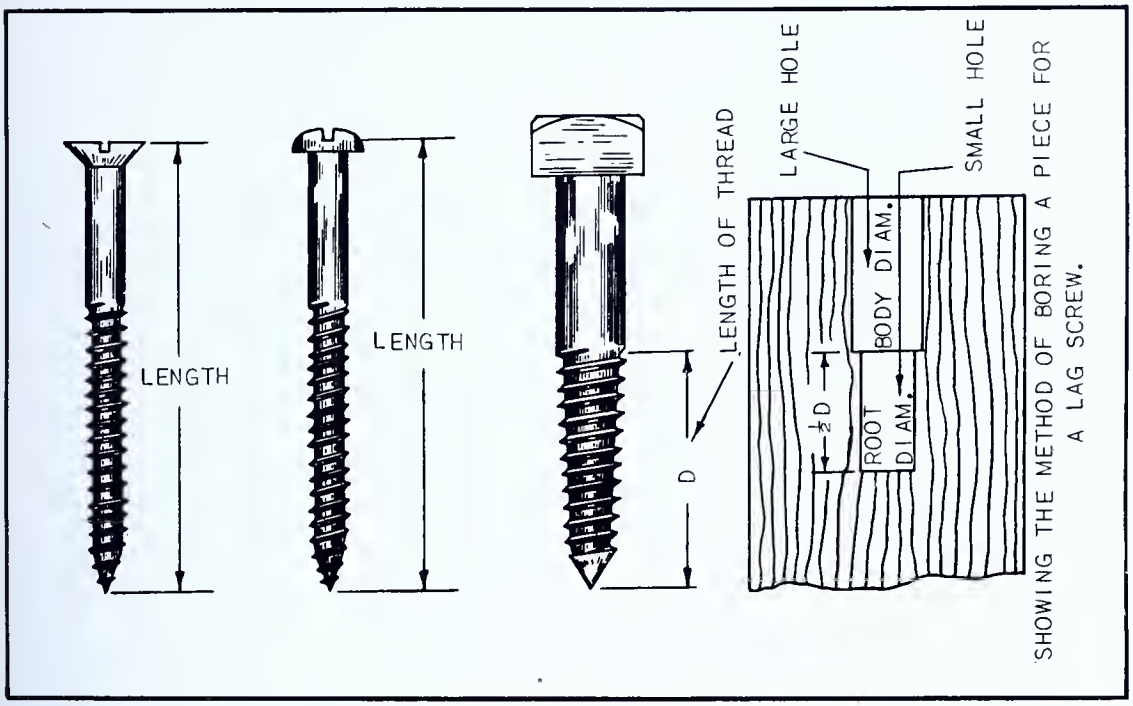


FIG. 294 — *Hole Size for Screws*

Screws: Types, Sizes, and Uses

In carpentry there are times when nails do not possess sufficient holding power, so screws are used in their stead. Screws are neat in appearance and are easy to remove when repairs are necessary. Nails are apt to bend and injure the material. Occasionally they work out while screws, if properly used, will not split the material nor work out.

There are many different kinds and sizes of screws; however, only those used in wood construction will be considered here. They are known as "wood screws," not from the material of which they are made but from the material on which they are used. It might be said that a wood screw is a nail with a right-handed coarse thread to give it a good grip, a gimlet point for ease in entering the wood, and a slotted head in which to place the screw driver. See Fig. 294.

There are several classifications of screws:

1. Material of which they are made:
   a. Brass
   b. Bronze
   c. Copper
   d. Iron
   e. Steel

2. Shape of the head. See Fig. 281.
   a. Flat
   b. Round (ordinary and piano)
   c. Flat (lag screws)
3. Duty
   a. Light (so-called wood screws)
   b. Heavy (lag screws)
4. Finish
   a. Blued
   b. Brassed
   c. Bright
   d. Bronzed
   e. Copper
   f. Galvanized
   g. Japanned
   h. Lacquered
   i. Nickel plated

Material

Ordinarily iron or steel screws are used. When other material is desired such as in shipbuilding where corrosion and electrolytic action must be avoided, brass or copper screws are used. If extra strength is required bronzed screws are used.

All screws, whether turned by a screw driver or a wrench, that are used in wood are known as wood screws; however, flat and round-headed screws are generally used.

TABLE IX

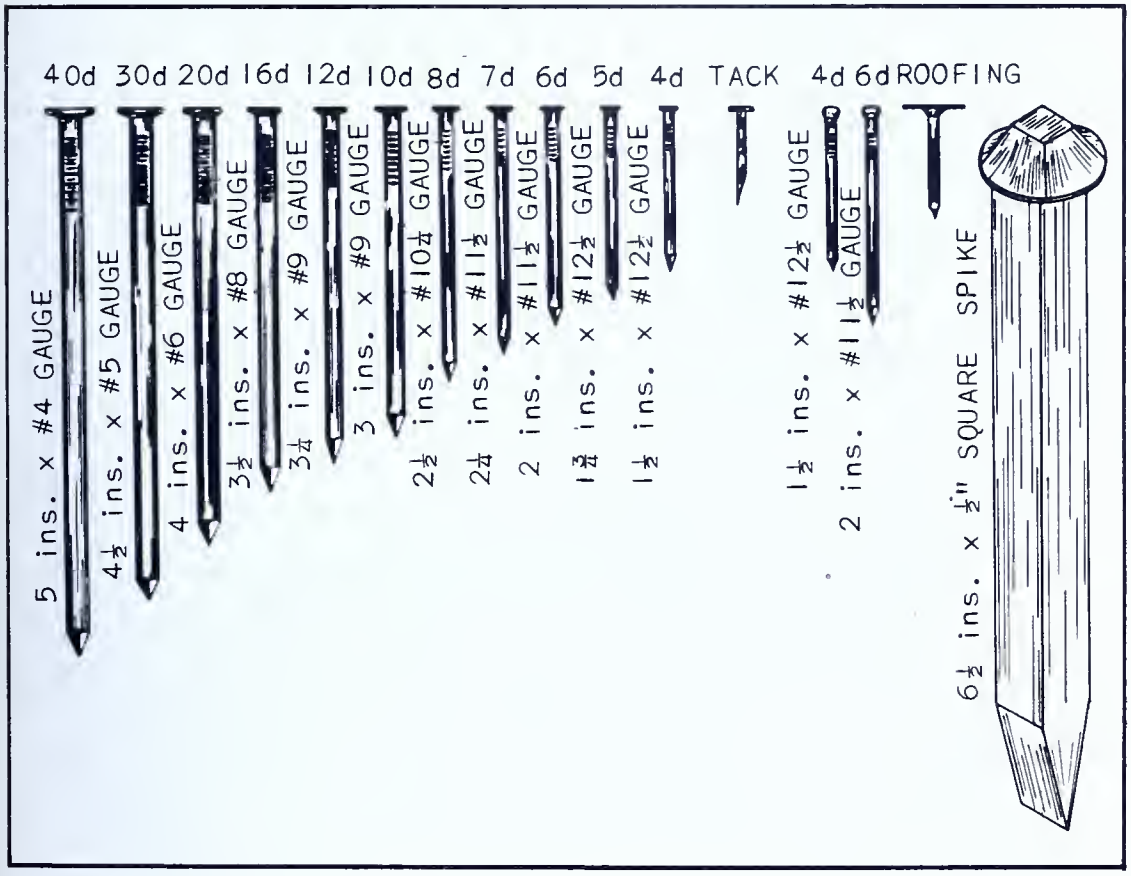


FIG. 295 — *Nails, Tacks, Spikes*

Nails: Types, Sizes, and Uses

The "Penny" System

In designating nail sizes the terms 6-penny, 8-penny, 10-penny, etc. are used. Penny (d) not only designates the length but also the gauge. A 4d nail is 1½ inches long and has a No. 12½ gauge, or a diameter of .08 inches. The smaller the gauge number the larger the nail. A 40d nail is 5 inches long and has a No. 4 gauge or a diameter of .204 inches. See Fig. 295.

Kinds of Nails

Different kinds and methods of construction require many different kinds of nails which may be classified as follows:

1. Cross-sectional shape
   a. Rectangular (cut)
   b. Circular (wire)

2. Size
   a. Tacks
   b. Nails
      (1) Common
      (2) Finishing
   c. Spikes (ordinary large)
3. Material of which they are made
   a. Brass
   b. Copper
   c. Steel
4. Finish
   a. Blued
   b. Coated (cement and sterilized)
   c. Galvanized
   d. Blain (smooth and barked)
5. Kind of service
   a. Boat
   b. Common
   c. Finishing
   d. Flooring
   e. Roofing

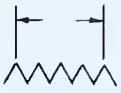
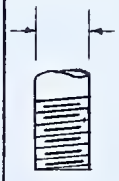
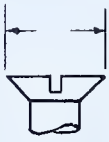
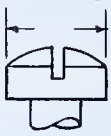
TABLE X

DIMENSIONS OF U. S. STANDARD BOLTS, HEADS, AND NUTS, ROUGH

Dia. of Bolt	No. of Thds. Per Inch	Short Dia. of Heads and Nuts Hex. & Sq.	Long Diameter of Heads & Nuts		Thickness Hexagon & Square		Dia. of Tap Drill	Root Diameter
			Hexagon	Square	Heads	Nuts		
		Distance Across Flats	Distance Across Corners				Nearest 64th	
1/4	20	1/2	37/64	23/32	1/4	1/4	13/64	.185
5/16	18	19/32	11/16	27/32	19/64	5/16	1/4	.240
3/8	16	11/16	51/64	31/32	11/32	3/8	5/16	.294
7/16	14	25/32	29/32	1- 7/64	25/64	7/16	23/64	.344
1/2	13	7/8	1- 1/64	1- 1/4	7/16	1/2	27/64	.400
9/16	12	31/32	1- 1/8	1- 3/8	31/64	9/16	15/32	.454
5/8	11	1- 1/16	1-15/64	1-1/2	17/32	5/8	17/32	.507
3/4	10	1- 1/4	1-29/64	1-25/32	5/8	3/4	41/64	.620
7/8	9	1- 7/16	1-43/64	2- 1/32	23/32	7/8	3/4	.731
1	8	1- 5/8	1- 7/8	2-19/64	13/16	1	55/64	.837
1-1/8	7	1-13/16	2- 3/32	2- 9/16	29/32	1-1/8	31/32	.940
1-1/4	7	2- 5/16	2-53/64	2-53/64	1	1-1/4	1- 3/32	1.065
1-3/8	6	2- 3/16	2-17/32	3- 3/32	1- 3/32	1-3/8	1-13/64	1.160
1-1/2	6	2- 3/8	2- 3/4	3-23/64	1- 3/16	1-1/2	1-21/64	1.284
1-3/4	5	2- 3/4	3- 3/16	3-57/64	1- 3/8	1-3/4	1-17/32	1.491
2	4-1/2	3- 1/8	3-39/64	4-27/64	1- 9/16	2	1- 3/4	1.712
2-1/4	4-1/2	3- 1/2	4- 3/64	4-61/64	1- 3/4	2-1/4	2	1.962
2-1/2	4	3- 7/8	4-31/64	5-31/64	1-15/16	2-1/2	2- 7/32	2.176
2-3/4	4	4- 1/4	4-29/32	6- 1/64	2- 1/8	2-3/4	2-15/32	2.426
3	3-1/2	4- 5/8	5-11/32	6-17/32	2- 5/16	3	2-11/16	2.629

TABLE XI

DIMENSIONS OF A. S. M. E. STANDARD MACHINE SCREWS

No.	Threads Per Inch 	Diameter of Body  D	Diam. of Flat Head  2D-.008	Diam. of Round Head 1.85D-.005	Diam. of Fillister Head  1.64D-.009	Lengths
0	80	.060	.112	.106	.0894	1/8" to 3/8"
1	72	.073	.138	.130	.1107	1/8" to 3/8"
2	64	.086	.164	.154	.1320	3/16" to 1/2"
3	56	.099	.190	.178	.1530	3/16" to 5/8"
4	48	.112	.216	.202	.1747	3/16" to 3/4"
5	44	.125	.242	.226	.1960	3/16" to 7/8"
6	40	.138	.262	.250	.2170	3/16" to 1"
7	36	.151	.294	.274	.2386	1/4" to 1-1/8"
8	36	.164	.320	.298	.2599	1/4" to 1-1/4"
9	32	.177	.346	.322	.2813	1/4" to 1-3/8"
10	30	.190	.372	.346	.3026	1/4" to 1-1/2"
11	28	.216	.424	.394	.3452	3/8" to 1-3/4"
14	24	.242	.472	.443	.3879	3/8" to 2"
16	22	.268	.528	.491	.4305	3/8" to 2-1/4"
18	20	.294	.580	.539	.4731	1/2" to 2-1/2"
20	20	.320	.632	.587	.5158	1/2" to 2-3/4"
22	18	.346	.682	.635	.5584	1/2" to 3"
24	16	.372	.732	.683	.6010	1/2" to 3"
26	16	.398	.788	.731	.6437	3/4" to 3"
28	14	.424	.840	.779	.6863	7/8" to 3"
30	14	.450	.892	.827	.7270	1" to 3"

Appendix III

BOLTS: TYPES, SIZES, AND USES

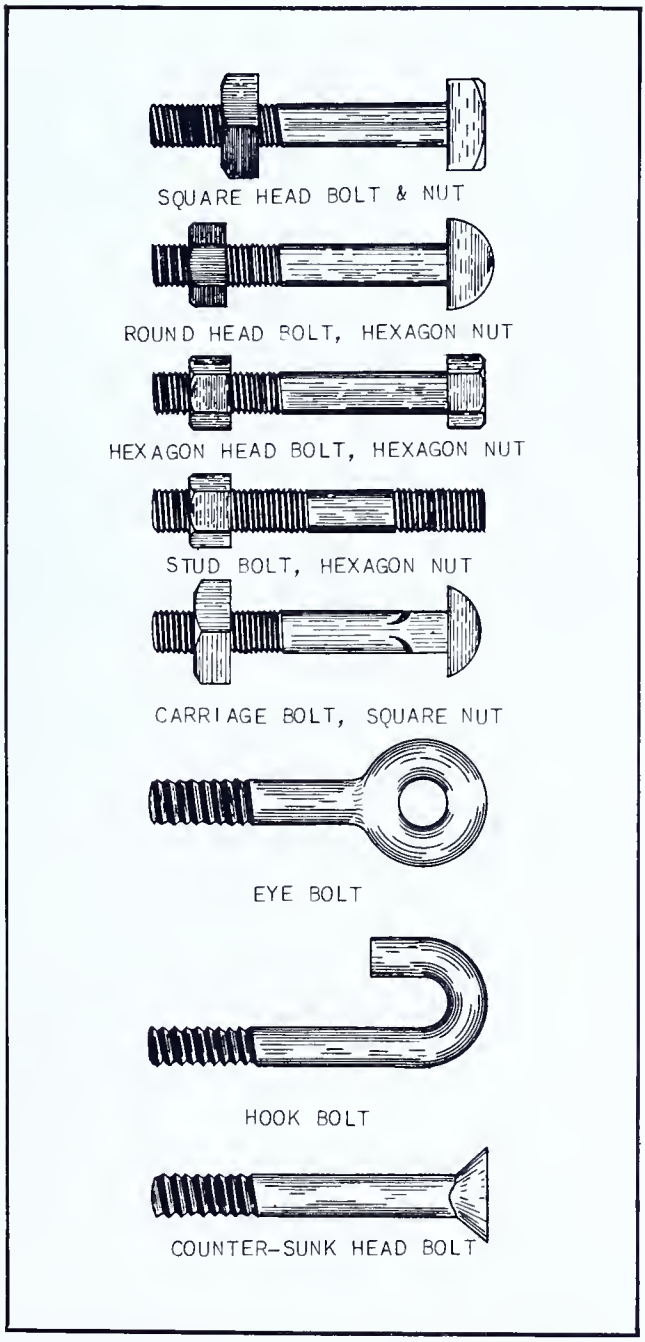


FIG. 296 — *Types of Bolts and Nuts*

A bolt is a pin or rod used for securing anything in units or parts of units in place.

A bolt generally has a head on one end, and is threaded at the other end to receive a nut; the nut is usually considered as forming a part of the bolt. A stud is much like a bolt except that it has no head and is threaded on both ends.

KINDS OF BOLTS. See Fig. 296.

1. Common or machine bolt — has a head on one end and a short length of thread at the other; made in the following combinations:
   a. Square head and square nut.
   b. Button head and hexagon or square nut.
   c. Hexagon head and hexagon nut.
   d. Carriage head and square nut.
2. Eye bolt — a bolt with a loop or "eye" instead of a head.
3. Hook bolt — a plain rod threaded on one end, with a hook bent on the other, to fasten around a flange of an iron or steel member.
4. Counter sunk bolt — a bolt with a beveled head fitting into a counter sunk hole.
5. Stud bolt — a rod threaded on both ends.

Appendix IV

APPLIED ARITHMETIC

Numerical Conversion (Decimals)

Decimal equivalents for fractional parts of an inch are encountered in all mechanical work. Circumferences are calculated or taken from already computed reference charts; in either case the results are always in inches and decimal parts of an inch. These decimals must be converted into fractions accurately in order to lay out the work correctly.

The conversion of a *decimal to a fraction* is the *reverse* of the conversion of a *fraction to a decimal.* For clarity of explanation the latter is presented first.

How to Change a Fraction to a Decimal

PROBLEM: Change 9/64 to a decimal.

Solution: Divide the numerator by the denominator as follows:

NOTE: The numerator is the part of the fraction above the horizontal line. The denominator is the part of the fraction below the horizontal line. For example:

$$\frac{9}{64}$$

9 (Numerator)

64 (Denominator)

$$64 \overline{)\,9.000000\,} .140625$$

64

260

256

400

384

160

128

320

320

Accordingly, .140625 is the decimal equivalent of 9/64.

How to Change a Decimal to a Fraction

PROBLEM: Change .140625 to a fraction the denominator of which is 64 (sixty-fourths).

Solution: Multiply the decimal by the denominator of the desired fraction (64).

$$\begin{array}{r} .140625 \\ 64 \\ \hline 562500 \\ 843750 \\ \hline 9.000000 \end{array}$$ (Answer in number of 64ths.)

Accordingly, 9/64 is the fractional equivalent of .140625.

For convenience any fractional part of an inch may be used; those shown on the mechanic's rule will be the most practical, as 1/64, 1/32, 1/16, 1/8, etc. For those wishing to learn this convenient method, it is well to practice with fractions like 1/64 and 1/32. It is always easier to multiply the decimal by 64 and then reduce the fraction to a denomination that is considered close enough for the job than to reduce the decimal directly.

Thus, .45312 x 64 = 28.999 sixty-fourths or 29/64ths. If multiplied by 32, .45312 x 32 = 14.4998 thirty-seconds, i.e., 14½/32nds. If multiplied by 16, .45312 x 16 = 7.2499 sixteenths, i.e., 7¼/16ths. This is an illustration of the convenience of reducing to 64ths.

The same rule may be applied to the decimals of a foot by multiplying the decimal by 12.

Extracting Square Root

GENERAL INFORMATION

On many jobs it is necessary to find diagonal or slanting distances. In the majority of cases these distances may be readily measured with a folding rule, a steel tape, or a measuring stick. There are certain jobs that can not be measured in this way because of temporary obstructions or because the size of the job may be beyond the capacity of the measuring tool. For example, it may be necessary to determine whether a bulkhead is, or is not, squared

with the position of the deck. Then, too, it may be necessary to know if certain vertical constructions are square with a horizontal member such as special staging or angular bracing. When it becomes necessary to take measurements and check jobs of this nature, the fundamental principles of square root may be employed. To understand these methods of measuring and checking thoroughly, it will be necessary to know how to extract the square root of a number.

Root of a Number. The root of a number is one of the equal factors which produce it, or it is the number used to start with.

Root Sign. The radical sign $\sqrt{}$ is used to indicate a root. A small figure placed over the radical sign indicates how many equal factors are to be found.

$\sqrt{3}$ or $\sqrt[2]{3}$ means to find the square root of 3.

The square root of 183184 will have three figures or three divisions, 18′ 31′ 84; 21418384 will have four figures and four divisions, 21′ 41′ 83′ 84; and 9703225 will also have four figures and four divisions — 9′ 70′ 32′ 25, but three divisions have two figures each, and one division has only one figure. Try finding the square root of 203401, marking it off into periods.

```
      20′  34′  01.      | 451 Ans.
  4   16
      434
 85   425
      901
901   901
```

Solution:

1. Separate the number into periods of two figures each, beginning at the decimal point.

2. Find the largest root which when squared will be contained in the left-hand period. This root is 4; place the 4 in the quotient as the first figure of the complete root.

3. Subtract the greatest square (16) from the first period (20), and bring down the next period with the remainder (4) making 434 for a new dividend.

4. Double the root already found (4) for a trial divisor ($2 \times 4 = 8$), and divide the trial divisor (8) into the new dividend (434) excluding the right-hand figure; this process ($43 \div 8$) gives 5. Place 5 after the 8 in the trial divisor, making 85; also place the 5 after the 4 in the quotient, making the quotient 45. Multiply the divisor (85) by the new root in the quotient ($5 \times 85 = 425$), and subtract this product from the new dividend ($434 - 425 = 9$). Then bring down the new period, which is 01, to make 901. Proceed as before for the next new root.

Try finding the square roots of the following:—

1. 784
2. 8464
3. 49729
4. 255036
5. 874225
6. 1799007056
7. 48841
8. 105976

Find Square Root of Decimals. To find the square root of a decimal begin at the decimal point and mark off periods to the right.

```
      .29'16          .54 Ans.
  5   25
     ----
      416
 104  416
     ----
```

To find the square root of a whole number and a decimal, begin at the decimal point and mark off two-figure periods to the right; then mark off two-figure periods to the left.

```
      5'80.81'        24.1 Ans.
  2   4
     ----
      180
 44   176
     ----
       481
481  481
     ----
```

Try finding the square roots of the following:

1. .625	4. 7832.25	7. 3124.81
2. .96721	5. 98.4064	8. .616225
3. .40401	6. 3.8416	9. 4.9284

Figure 297 shows two lines at right angles to each other. The length of one side is 4 in. The length of the other side is 3 in. The distance "A" may be found by using the principles of square root. The principles of square root are shown in Fig. 298.

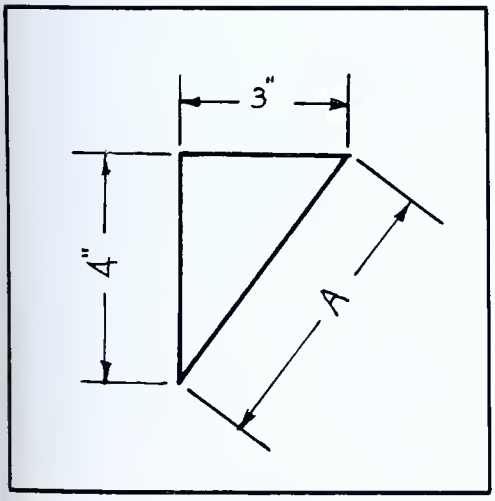


Fig. 297

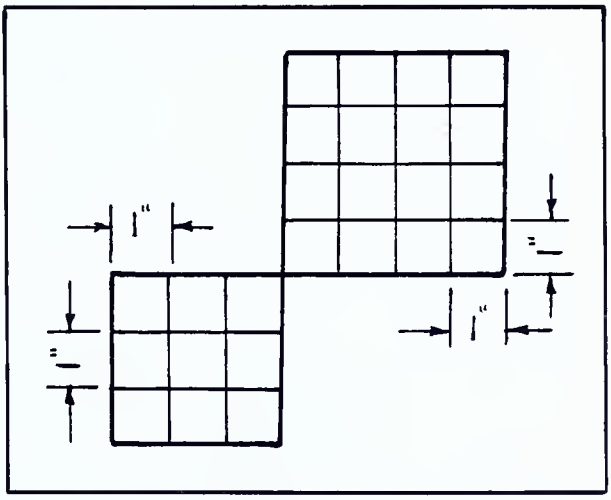


Fig. 298

A square is built around, or formed around, the first side, 4 in. each way. This is called "squaring" 4 in. The squares are 1 in. each way. A square is built the same way on the 3-inch side. The 3-inch side is now "squared."

Examine the number of squares. 16 squares will be formed in the large square; 9 squares will be formed in the small square. Add the squares together. There are 25 in all. Examine Fig. 299.

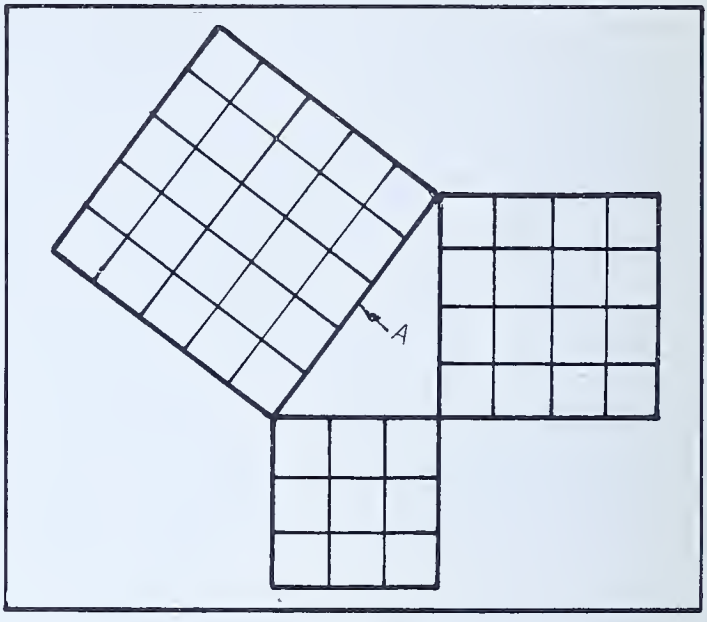


Fig. 299

Add the squares in the two small squares making 25 in all. Count the squares in the largest square. There are 25 squares of the same size in the smaller squares. The length of side "A" must be the square root of 25 which is 5, for $5 \times 5 = 25$.

From the example the standard rule for finding the length of the third side of a right-angled triangle follows:

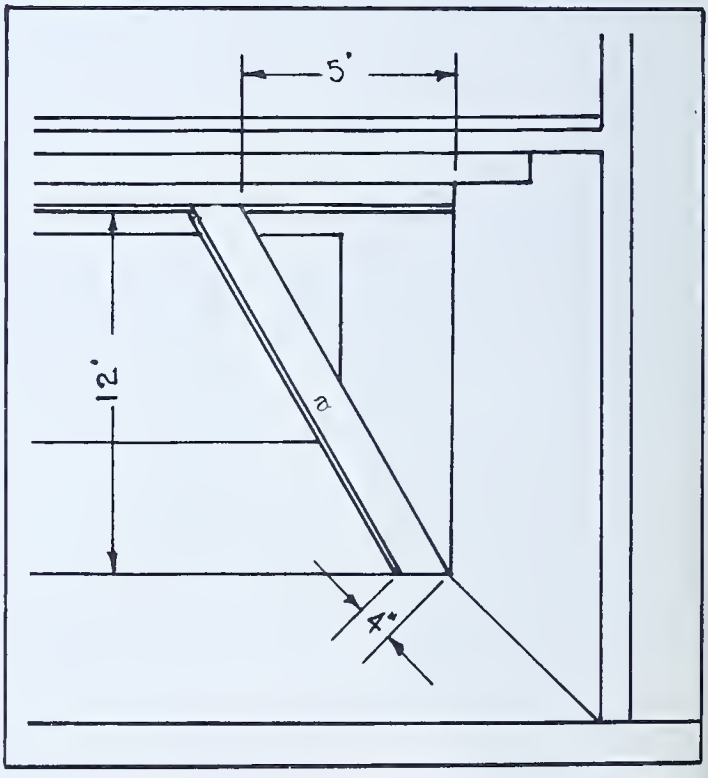


Fig. 300

Rule:

1. Square each side of the triangle.
2. Add the squares together.
3. Extract, or find, the square root of the sum of the squares.

The answer will be the length of the third side.

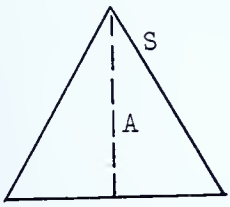
Problem: Find the length of the slanting timber "a" shown in Fig. 300.

Common Formulas

The carpenter is often called upon to build concrete forms, stack forms, staging for stacks, and other similar structures. The carpenter who does maintenance work is often required to obtain measurements of sections of previously built structures and to make and install blocking to be used for the shipment of heavy cylindrical tanks and large boilers. He may be called upon

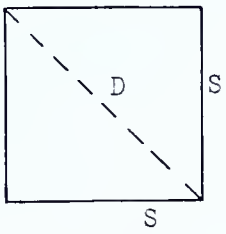
Uses of Some Common Formulas

EQUILATERAL TRIANGLE



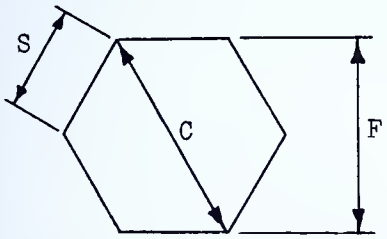
LET S = SIDE
A = ALTITUDE
A = 0.866 x S
S = 1.155 x A
AREA = 0.433 x S^2
= 0.577 x A^2

SQUARE



LET S = SIDE
D = DIAGONAL
D = 1.414 x S
S = 0.707 x D
AREA = S x S

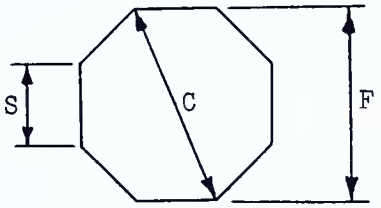
HEXAGON



Let F = Distance Across Flats
C = Distance Across Corners
S = One Side

F = 0.866 x C F = 1.732 x S
C = 2 x S C = 1.155 x F
S = 0.5 x C S = 0.577 x F
AREA = 0.650 x C^2
2.598 x S^2
0.866 x F^2

OCTAGON



Let F = Distance Across Flats
C = Distance Across Corners
S = One Side

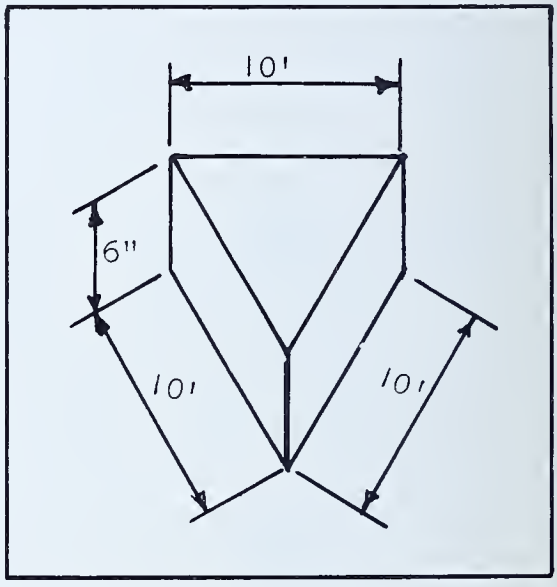
S = 0.414 x F S = 0.383 x C
C = 1.083 x F C = 2.613 x S
F = 0.924 x C F = 2.414 x S
AREA = 0.828 x F^2
0.707 x C^2
4.828 x S^2

to figure the area of planking covering hexagonal, octagonal, or triangular platforms.

The ship maintenance carpenters who are employed on the work in and around the area adjacent to the ways may find it necessary to figure the amount of mixed cement which will be required to fill an enclosed triangular, square, hexagonal, or octagonal structure built of planking.

The use of the common formulas given below will greatly aid the mechanic in this work.

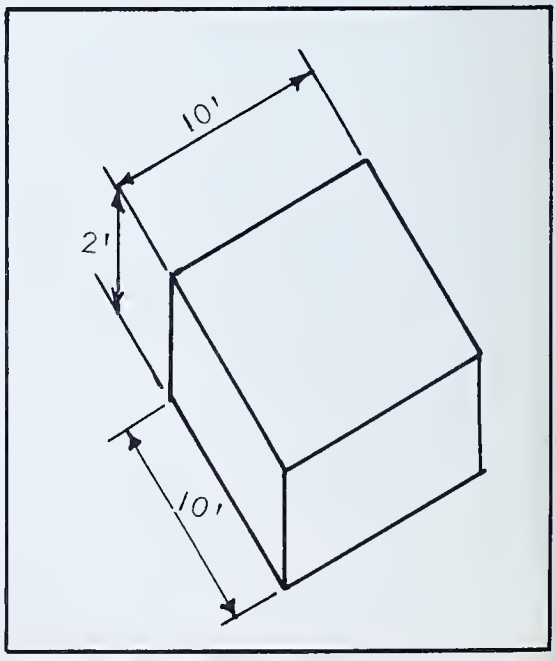
PROBLEM I: Determine the amount of cement that will be required to fill to a depth of 6 inches an equilateral triangular form the sides of which are 10′ long.



Solution: From the formula given on Page 337 the area of the triangle is found to be: $0.433 \times S^2 = 0.433 \times 10^2 = 0.433 \times 10 \times 10 =$ 43.3 sq. ft.

The volume = Area x Depth = $43.3 \times \frac{1}{2} = 21.65$ cubic feet.

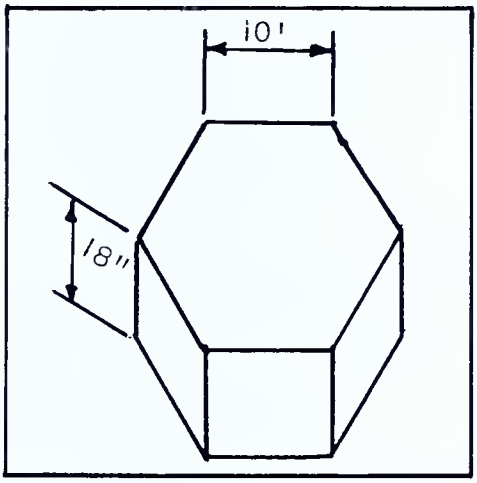
PROBLEM II: Determine the cubic contents of a form 10′ square and 2′ deep.



Solution: From the formula given on Page 337 the area of a square is found to be: S x S = 10 x 10 = 100 sq. ft.

The volume = Area x Height = 100 x 2 = 200 cubic feet.

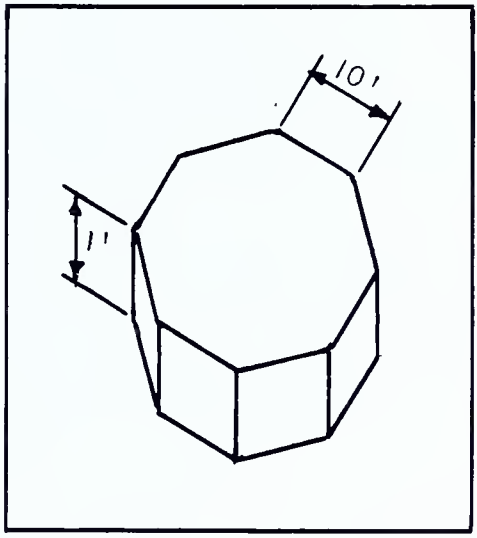
PROBLEM III: Find the cubic contents of a hexagonal form which measures 10′ on each side and 18″ deep.



Solution: From the formula given on Page 337 the area of the hexagon is found to be: $2.598 \times S^2 = 2.598 \times 10 \times 10 = 259.8$ sq. ft.

The volume = Area x Depth = $259.8 \times 1\frac{1}{2} = 389.7$ cubic feet.

PROBLEM IV: What is the volume of an octagonal block of concrete which measures 10′ on each side and 1 foot thick?



Solution: From the formula given on Page 337 the area of the octagon is found to be: $4.828 \times S^2 = 4.828 \times 10 \times 10 = 482.8$ sq. ft.

The Volume = Area x Depth = $482.8 \times 1 = 482.8$ cubic feet.

Appendix V

PROPERTIES OF WOODS

The following information on the properties of woods is given to enable the worker to select the material which he may be asked to find in the stock pile, in the storeroom, or elsewhere about the shipyard. A close study of this information about the woods will reveal many of the characteristics which are commonly overlooked. Practice in selecting the different kinds of wood is necessary in addition to the information given here.

LIGNUM VITAE — It is exceedingly heavy, hard, difficult to split or work, and has a soapy feeling. Its color varies from a rich yellow-brown to almost black. It is used for sheaves of block pulleys, for mast trucks, and for stern-bushing bearings.

WHITE OAK — White oak is heavy, strong, hard, tough, and close-grained. It will check if it is not carefully seasoned. It is brown, with lighter-colored sapwood. It is much used for frames and outside planking of wood ships, and for foundations, fender logs, etc., on steel ships. It is also used for various construction operations.

WHITE PINE — White pine is light, soft, straight-grained, and easily worked but not very strong. It has a light yellowish-brown color often slightly tinged with red. Its chief uses are for interior finishing, doors, sash, pattern making, and mold-loft templates.

YELLOW PINE (long-leaf) — This type of yellow pine is heavy, hard, strong, coarse-grained, and very durable when dry and well-ventilated. In color, it is light yellowish-red or orange. It cannot be used in contact with ground. It is used for heavy framing timbers and floors, machine foundations, spars, keel blocks, and ship fenders.

YELLOW PINE (short-leaf) — This type of yellow pine varies greatly in the amount of sap and in quality. Its color is orange, but the sapwood is white. It is used as a substitute for long-leaf pine. One of its chief uses is for shores under ships.

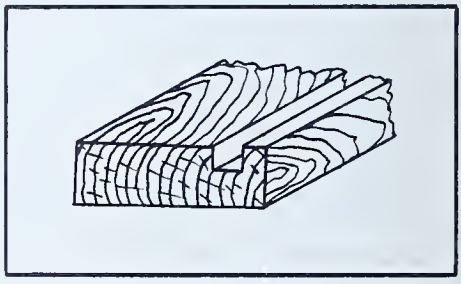
Fir — Fir is hard and strong, but its strength varies greatly with age. It is durable, but difficult to work. Its color ranges from light red to yellow; the sapwood is white. Fir is used for ceilings, staging, cargo battens, back rails, forms, boxes, and general construction.

White Spruce — Spruce is light, soft, and of medium strength. It is light yellow in color; the sapwood is indistinct. It is used as lumber for construction, hatch covers, cargo battens, boxes, and sheathing on bulkheads.

Common Cuts in Wood

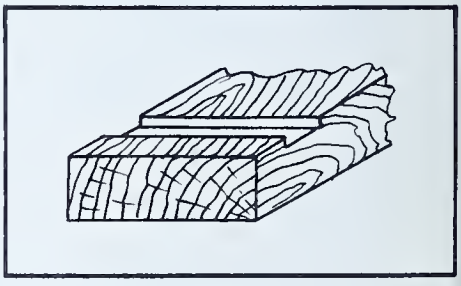
In shipyard repair work and in the construction of new ships, a ship's carpenter must be able to make a wide variety of cuts in wood. Most of the cuts used in ship carpentry can be very easily made on power equipment, but they may also be turned out with the proper hand tools. In either case it is very important that the tools used should be sharp. A cut for a well-fitting joint cannot be made with dull equipment. Special hand tools are available for making the more complicated cuts.

1. *Plow cut.* This cut is sometimes referred to as a groove. It is a very common cut. It runs with the grain of the wood and can be made with a table saw equipped with a dado head, or it may be cut with a plow plane.



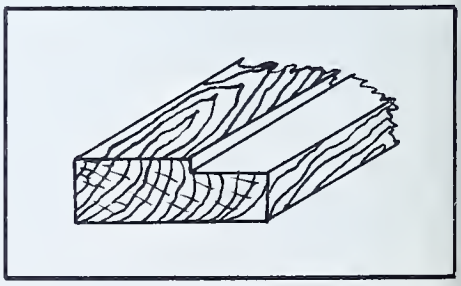
1. *Plow*

2. *Dado Cut.* This cut is made across the grain of a piece of wood; it is a much-used cut for joints in cabinet work. This cut is best made on a saw equipped with a dado head, or it can be made with a dado plane.



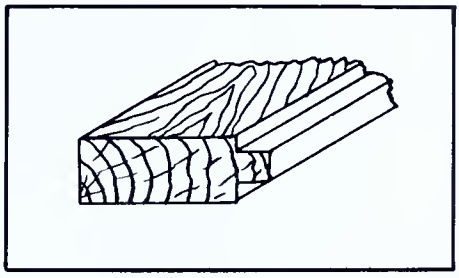
2. *Dado*

3. *Rabbet Cut.* The rabbet cut is probably used more than any other cut in ship carpentry. It is a groove cut longitudinally in the edge of a plank, etc., so that another plank may fit into it. This cut can be made with a table saw or a rabbet plane. In some cases this cut must be worked in with a chisel.



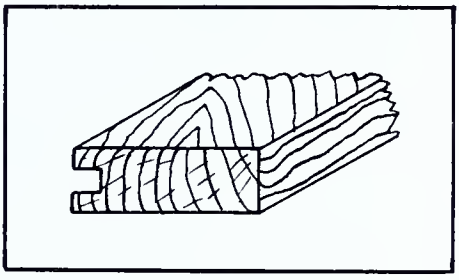
3. *Rabbet*

4. *Tongue Cut.* This is a cut used on one edge of "tongue and groove" lumber. It is best run out on a shaper, or it may be cut with a Stanley "Fifty-Five" plane. This cut is used on most ceiling.



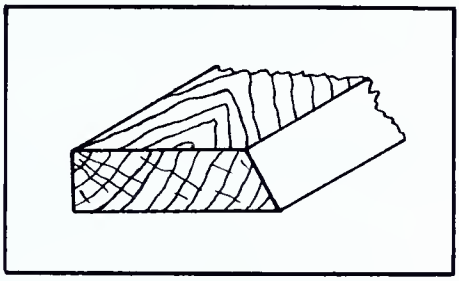
4. *Tongue*

5. *Groove Cut.* This cut is used on "tongue and groove" lumber. It is used on most ceiling. The cut is usually run out on a shaper; it, too, can be made with a Stanley "Fifty-Five" plane.



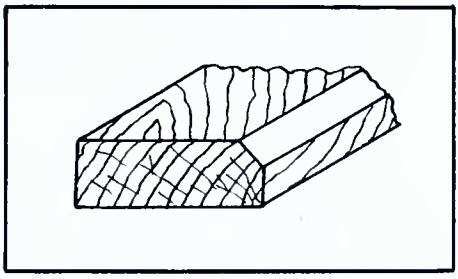
5. *Groove*

6. *Bevel Cut.* This cut is also used a great deal in ship carpentry. Bevels are cut at all angles. Bevels may be cut with table saw, handsaw, band saw, plane, etc.



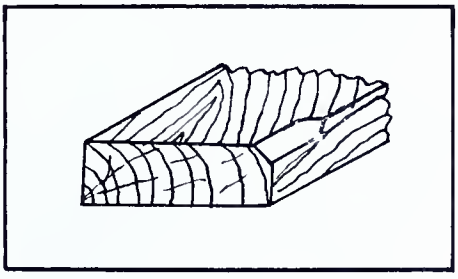
6. *Bevel*

7. *Chamfer.* This is a bevel cut made on the edge of a piece of wood. It is usually cut at 45°. It differs from a bevel in that the cut affects only one edge of the piece of wood being worked. This cut is usually made with a plane.



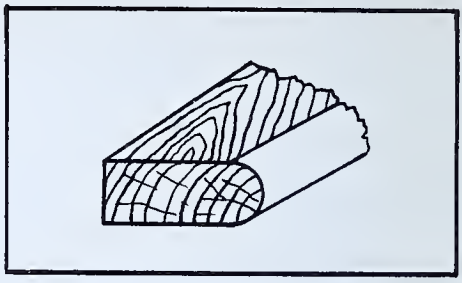
7. *Chamfer*

8. *Stop Chamfer.* This is the same cut as a chamfer with the exception that the cut does not run the full length of the piece of wood. The cut stops with an upward sweep. It can be cut with a plane, drawknife, shaper, etc.



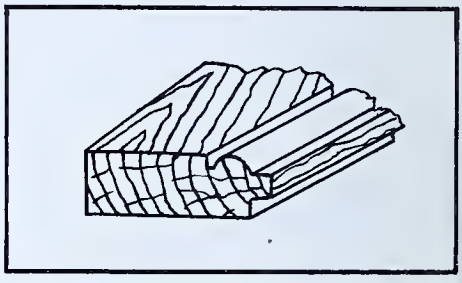
8. *Stop Chamfer*

9. *Nosing.* This is a cut which rounds off one edge of a piece of wood to a true radius. In ship work the cut is used on window stops, stair treads, etc. The cut is best worked out on a shaper, but it can be worked out with a plane.



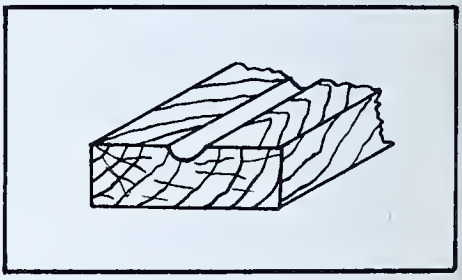
9. *Nosing*

10. *Edge Bead.* This cut is used in ship joinery work. It is used in decorative inside work. It is usually made on a shaper, but it, too, can be made with a Stanley "Fifty-Five" plane.



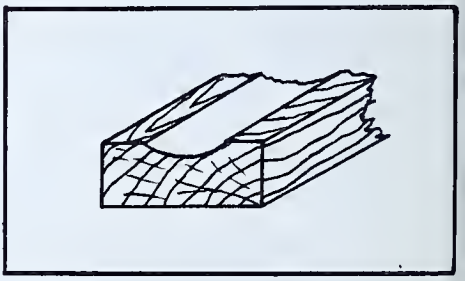
10. *Edge Bead*

11. *Flute.* A flute is used in decorative inside work. It is also used at times in places where wires run behind a panel. This cut can be made with a fluting plane, a Stanley "Fifty-Five" plane, or a shaper.



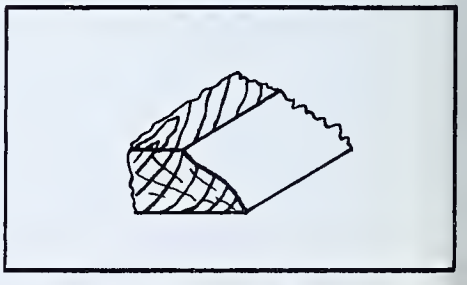
11. *Flute*

12. *Hollow.* This cut is very similar to the flute; the only difference is that it is wider.



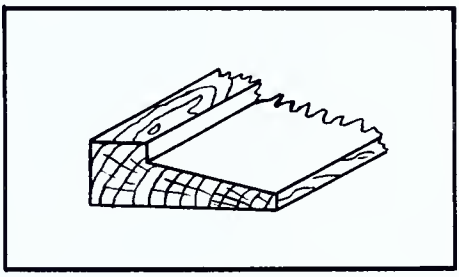
12. *Hollow*

13. *Reverse Ogee.* This cut is used on moldings, etc. It is best worked out on a shaper.



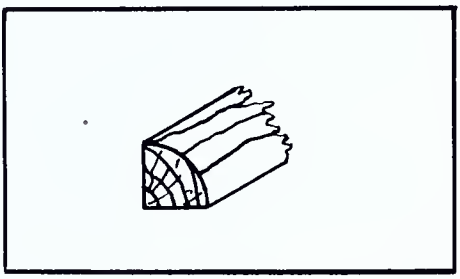
13. *Reverse Ogee*

14. *Ship Lap.* This is a very good cut for joining together heavy pieces of wood, because it makes a strong joint. This cut is usually worked out in the mill on a shaper.



14. *Ship Lap*

15. *Quarter Round.* This cut is used in making moldings. It is worked out in the mill.



15. *Quarter Round*

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